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The Week In Engineering and Construction

ENGINEERING NEWS-RECORD • JANUARY 10, 1946 • VOLUME 136 • NUMBER 2

Home-building priorities to go into effect January 15

Distribution of ten classes of supplies will be controlled by new regulation—Move expected to ease bottlenecks in supply, make more homes available for veterans

The Civilian Production Administration Jan. 15 will place in effect a priorities regulation to provide assistance to builders of moderate-cost housing for veterans in getting deliveries of ten classes of construction materials now in short supply.

The move is a result of the President's approval of a 3-point program of Reconversion Director John W. Snyder, who proposed use of priority controls to aid construction, speed up release of surplus war housing, and to establish ceiling prices on sales of old and new housing (*ENR* Dec. 20, 1945, vol. p. 831).

Issued as Priorities Regulation 33, the new control makes available a new priority, designated *HH*, to assist organizations constructing housing where veterans will be given first preference for purchase or renting. The new control is much different from the former overall WPB control Order *L*-41, which was removed Oct. 15. Order *L*-41 restricted construction, while the new control permits any type of construction to go ahead, but gives preference to veterans' housing in obtaining building supplies.

Since Oct. 15 only three priorities to obtain construction supplies have been available. These are: The *AAA* priority, which is issued in emergencies to permit military or civilian projects of great importance to the country to advance, the *MM* rating issued sparingly for military and Veterans Administration projects, and the *CC* rating employed to break bottlenecks on civilian construction. All of the ratings just listed have been issued infrequently and as a result the construction industry for several weeks has been practically free of priority control.

Control of only ten materials

When Mr. Snyder's program was announced it was reported that 50 percent of all building materials normally used for housing would be channeled into moderate-cost construction for veterans. However, now that details of the program are being determined, it has been decided that only ten classes of materials will need to be placed under control at the start. The percentage of each class to be allotted for housing will vary greatly and generally will be less than 50 percent of the output.

The ten materials to be controlled and the output of each considered necessary for veterans' housing in 1946 are as follows:

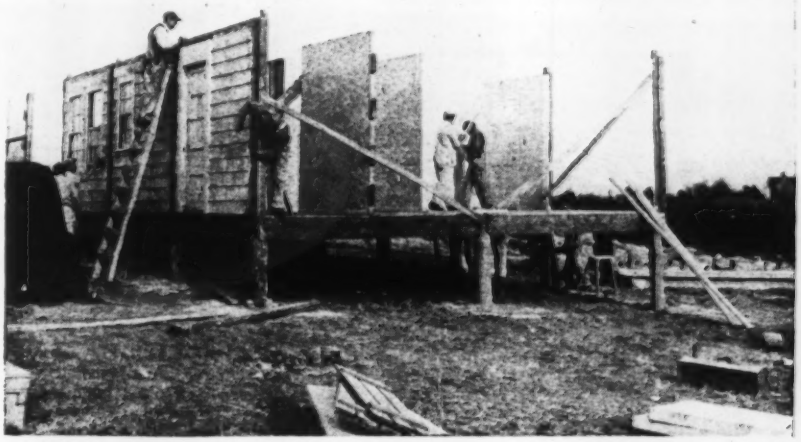
Common and face brick	50 percent
Clay sewer pipe	1 "
Structural tile	10 "
Gypsum board	45 percent
Gypsum lath	45 "
Cast iron soil pipe	35 "
Cast iron radiators	69 "
Bathtubs	55 "
Lumber (total)	14 "
Millwork	33 "

A number of other items now in short supply are being studied as possible additions to the list. Materials in this class include heating equipment, concrete blocks, plumbing supplies and electrical supplies.

The *HH* rating will be equal to the *CC* priority. It will be granted only if the homes will be offered for sale to veterans at less than $10,000 for 30 days, or will be made available for 30 days for renting to veterans at $80 or less monthly. In case the builder is a veteran and is constructing a dwelling for himself, he may get assistance if the total cost, including the land, is less than $10,000.

Other requirements to be met before the priority will be issued are: (1) The land must be available, (2) the applicant must be able to show that the financing has been arranged, and that

(*Continued on p.* 102)



Demonstrating one solution of the housing problem

One solution for the pressing problem of providing housing for war veterans and civilians is demonstrated as workmen at Silver Springs, Md., re-erect a war housing unit.

The unit will be one of some 43 buildings, erected on the site by the Federal Public Housing Authority to demonstrate the possibilities of reuse of the structures. The demonstration will open officially Jan. 12, and continue through Feb. 9. It provides a 20-acre "showcase" of all major types of temporary wartime buildings, and a cross section of many different structures into which the buildings can be converted for peacetime use.

Housing Priorities Set

(*Continued from page* 101)

(3) actual construction will be started within 60 days. (It is planned to change this period to 90 days in the near future). The priority aid, of course, will be issued for dwelling construction already under way, providing the housing is to be sold or rented to veterans within the rates listed.

The CPA said the new regulation is not meant to interfere with construction under way or planned, provided the builder takes his chances in getting deliveries from the portion of the supplies not allotted to veterans' housing. This rule will be followed regardless of the cost or type of construction.

FHA to issue priorities

Because no other federal agency has as adequate a staff for the job, the Federal Housing Administration will issue the *HH* priority and see that it is used properly.

The FHA has informed *Engineering New-Record* that the applications will be handled by local offices of the agency. An accompanying table supplies the location address of these offices. In seeking priority help, the applicant must use a special form CPA 4386, soon to be available at all FHA offices. The American Bankers Association also plans to distribute the application blanks, along with a digest of the new controls.

Whether the priority control will be enforced at the retail yards or on the deliveries from wholesale establishments has not been determined. Undoubtedly, the level of the new priority control will vary with the product.

The CPA and the FHA hope that 400,000 to 500,000 new dwelling units can be built with priority assistance during 1946.

For housing priorities, apply below:

Alabama: Twenty-fourth Floor, Comer Bldg., Birmingham.
Arizona: 1405 Central Ave., Phoenix.
Arkansas: Old Post Office Bldg., Little Rock.
California: 315 Montgomery St., San Francisco.
Broadway Bldg., San Diego.
Rives-Strong Bldg., 112 W. 9th St., Los Angeles.
Colorado: 203-211 Boston Bldg., Denver.
Connecticut: 125 Trumbull St., Hartford.
Delaware: Industrial Trust Bldg., Tenth and Shipley Sts., Wilmington.
District of Columbia: 1021 Fourteenth St. NW., Washington.
Florida: Greenleaf Bldg., Jacksonville.
Coral Gables City Hall, Miami.
Georgia: 101 Marietta Street Bldg., Atlanta.
Hawaii: 334-336 Federal Bldg., Honolulu.
Idaho: 410-414 Capital Securities Bldg., 805 Idaho St., Boise.
Illinois: Rm. 506, Merchandise Mart, Chicago, Ill.
605 Illinois Bldg., Springfield.
Indiana: Guaranty Bldg., Monument Circle, Indianapolis.
Iowa: Insurance Exchange Bldg., Des Moines.
Kansas: National Bank of Topeka Bldg., Topeka.
Kentucky: American Life & Accident Bldg., Fifth and Main Sts., Louisville.
Louisiana: 4th Floor, Richards Bldg., New Orleans.
Maine: Exchange Bldg., Bangor.
Maryland: 915 Fidelity Bldg., Baltimore.
Massachusetts: 5th Floor, 40 Broad St., Boston.
Security Bldg., 44 Vernon St., Springfield.
Michigan: 3d Fl., Penobscot Bldg., Detroit.
516-518 Grand Rapids National Bank Bldg., Grand Rapids.
Minnesota: New Post Office Bldg., Minneapolis.
Mississippi: 203-A Lamar Life Bldg., Jackson.
Missouri: 315 North Seventh St., St. Louis.
12th Floor, Land Bank Bldg., Kansas City.
Montana: Federal Bldg., Helena.
Nevada: Lunsford Bldg., Reno.
Nebraska: Woodmen of the World Bldg., Fourteenth and Farnam Sts., Omaha.
New Hampshire: 70 Market St., Manchester.
New Jersey: Raymond-Commerce Bldg., Newark.
Post Office Bldg., Camden.
New Mexico: 326 N. Third St., Albuquerque.
New York: Rm. 2204, 2 Park Ave., New York City.
The City and County Savings Bk. Bldg., 100 State St., Albany.
Post Office Bldg., Buffalo.
North Carolina: Guilford Bldg., Greensboro.
North Dakota: 621-23 First Ave. North, Fargo.
Ohio: Old Post Office Bldg., Columbus.
New Post Office Bldg., Cleveland.
Rm. 15, Old Customhouse, Toledo.
Schmidt Bldg., Sixth and Main Sts., Cincinnati.
Oklahoma: 2d Floor, Cotton Exchange Bldg., Oklahoma City.
Oregon: Rm. 520, Platt Bldg., Portland.
Pennsylvania: 4th Floor, Public Ledger Bldg., Philadelphia.
Henry W. Oliver Bldg., 535 Smithfield St., Pittsburgh.
Puerto Rico: Banco Popular Bldg., P. O. Box 3592, San Juan.
Rhode Island: Old Colony Bank Bldg., 58 Weybosset St., Providence.
South Carolina: Federal Land Bldg., Columbia.
South Dakota: New City Hall, Sioux Falls.
Tennessee: 210 Federal Bldg., Memphis.
Texas: 215 Cotton Exchange Bldg., Dallas.
906-913 Electric Bldg., Fort Worth.
8th Floor, Rusk Bldg., 723 Main St., Houston.
5th Floor, Alamo National Bank Bldg., San Antonio.
Utah: 520 Dooley Bldg., 109 W. Second St., South, Salt Lake City.
Vermont: Parkhill Bldg., 200 Main St., Burlington.
Virginia: 1005 East Main St., Richmond.
Washington: 4th Floor, Dexter-Horton Bldg., Seattle.
West Virginia: Chamber of Commerce Bldg., Charleston.
Wisconsin: 4th Floor, Wisconsin-Broad-Bldg., Milwaukee.
Wyoming: Post Office Bldg., Cheyenne.

Huge breakwater creates new harbor at Neah Bay

Moving toward development of additional harbor facilities at Neah Bay on the Strait of Juan de Fuca, the Seattle District Army Engineers called a hearing recently to determine what navigational improvements are desired there, whether the Neah Bay project should be modified, and to determine the amount and character of erosion that may have been caused by the breakwater.

In this first disclosure of the development, heretofore unannounced because of security regulations, engineers said the huge breakwater was completed in 1944 to afford a protected harbor for the Navy, Coast Guard, logging, and fishing vessel operators, under a $1,808,988 contract.

Situated on the western end of the strait, it is of a rubblestone type, approximately 8,220 ft. long, with a 14-ft. crest and a 16-ft. width, both at mean low water. Extending from a point on the mainland three-quarters of a mile north of Neah Bay, easterly to Waadah Island, the structure contains over 1,194,051 tons of quarry rock. The breakwater was the only new civil works construction undertaken in the Seattle Engineer District during the war.

Its location, 65 miles nearer the fishing banks than any other U. S. harbor, has resulted in the appreciable lengthening of fishing work days in the area.

No adequate building supplies seen available until middle of 1946

Some materials now critically short will continue so for several weeks, but by next summer general supply picture should improve

Despite notable production progress late in 1945 in production of many critical construction materials, the outlook for adequate building supplies for early 1946 is not good, according to the most recent report of the Construction Division of the Department of Commerce.

Data gathered by the office of economic research of the Federal Works Agency, however, shows that by the middle of this year the production of building materials should be sufficient to meet the actual demand, although many inventories will still be low.

This optimistic view is taken because of the recent gains in rate of production and the fact that time will be required for contractors to get their forces organized. The delay by some highway departments and other organizations in awarding contracts and the winter weather which is delaying construction in the northern states are other factors expected to help in improving the supply picture.

Most critical materials at the present time are cast iron soil pipe, heating equipment, gypsum lath, lumber and lumber products, including millwork, cast iron enameled plumbing fixtures, and cast iron radiators. But the rate of production of most supplies is expected to be increased appreciably by early spring.

A composite report regarding the supply of specific materials, as pictured by both agencies, follows:

Steel—Current production reaching higher levels than anticipated. If the strike called for January 14 does not materialize, outlook is good, otherwise priorities may be reinstituted. At year's end unfilled orders of fabricated structural shapes equalled about 15 months of current shipment and backlog of orders was increasing. Demand for reinforcing bars exceeds production with indefinite delivery delays. Increasing order backlog makes delivery of plate slow. Sheet and strip remain tight. No decline in demand for pipe, although wrought iron pipe is readily available.

Cast iron soil pipe—Production improving steadily but supply still short, with inventories negligible. Unfilled orders equal about 11 months' current shipment.

Cast iron pressure pipe—Position somewhat better than soil pipe. Orders heavy and increasing.

Portland cement—Ample supply, but increasing orders, lack of coal and manpower impeding building up of inventories.

Concrete masonry products

Building block—Increased demand arising from expanding construction volume can be met by increased manpower.

Concrete pipe—Available with moderate delays. Plants are operating to capacity of the present labor supply available.

Structural insulating board—No great improvement in production has occurred and increasing demand prevents building up of inventories.

Gypsum board—Supply generally adequate for current construction activity and current shipments are about 80 percent of the production capacity. Rising trend in production of gypsum lath indicates some lessening of difficulties in filling orders.

Asbestos-cement products—In general, production of flat sheets, corrugated roofing and siding, shingles, insulation materials and pipe far behind orders.

Asphalt—Currently in ample supply, but there may be some localized shortages due to transportation difficulties.

Asphalt roofing, siding, felts—Heavy demands by floor covering and automotive industries causing shortages for construction. Large maintenance and repair demands in prospect. Backlog of orders continues heavy and two to three months delay in deliveries can be expected.

Clay products

Common and face brick—Preliminary estimates indicate increasing production but supply expected to be difficult until next spring and possibly throughout 1946.

Structural clay tile—Recent spot survey showed sharp gains in production at the end of 1945. However, use of substitutes may be necessary through much of 1946.

Vitrified clay sewer pipe—Shipments continue to exceed production, which is slowly improving, but not in proportion to increasing backlog of orders.

Floor and wall tile—Stocks are low, but production capacity is ample.

Unglazed hollow facing tile—The national backlog of orders is about equal to four month's average production and is rapidly increasing.

Glazed hollow facing tile—Unfilled orders increasing at accelerating rate.

Vitrified paving brick—Ample supply.

Lumber and lumber products

Lumber—Production declining. Labor difficulties in winter producing areas, cost-price relationships and continued manpower shortages principal contributing factors. Mill and distributors stocks at an all-time low. No signs of increasing stocks of seasoned lumber.

Hardwood flooring—Production not keeping pace with construction demands and unfilled orders are equal to two months of current monthly production.

Millwork—Order files greatly in excess of the industry's ability to produce at present level of labor and material supply, but situation should improve as lumber supply becomes easier.

Wood shingles—Although current production is low, picture is improving.

Plywood—Production low, but some gains reported in warehouse inventories.

Metal building materials

Steel windows—Both industrial and residential windows continue in tight supply. Stocks low.

Bar joists—Delivery delays should be expected.

Hardware—Standard and miscellaneous hardware is generally available.

Nails—Small size nails continue in short supply and larger sizes obtainable.

Plumbing supplies

Cast iron bath tubs—Labor difficulties settled and early improvement in production expected.

Steel bath tubs—Production has been resumed and should increase rapidly.

Hot-water tanks (galvanized)—Unfilled orders about equal to eight months' production.

General—Other plumbing materials and fixtures not in very good supply, and subject to delivery delays.

Cast iron boilers—Production slow and small house sizes still in short supply.

Cast iron radiators—Production and stocks low. Situation shows no improvement.

Various agencies act in housing crisis

While the pricing agencies of the federal government sought means to expedite small housing construction, other federal agencies and local governmental units last week took steps toward their own solution of the housing problem.

At Washington, Raymond M. Foley, Commissioner of the Federal Housing Administration, announced the appointment of Franklin D. Richards, of Salt Lake City, Utah, as assistant commissioner for field operations for the FHA.

At Pittsburgh, Pa., the city council's finance committee, following suggestions of the city's new mayor, David L. Lawrence, introduced a resolution urging that unused office buildings in the downtown section be converted temporarily for dwellings.

At Indianapolis, Ind., 40 barracks located at Stout Field, will be converted into 400 apartments for veterans and their families shortly after Feb. 1, and the city took action to obtain about 100 Quonset huts as further housing units.

In New York City work started on the conversion of barracks at Fox Hills, Staten Island, and at Manhattan Beach, Brooklyn, to make homes for veterans. Meanwhile, Mayor William O'Dwyer said he was considering plans for erection of Quonset huts on unused city-owned property in Brooklyn for the same purpose.

Citizens of Grand Coulee, Wash., opposed a Bureau of Reclamation plan to construct $9,250,000 worth of government housing units at the town of Coulee Dam, countering the proposal with the statement that private interests had already formed a building corporation which is prepared to erect $1,000,000 worth of new housing in the community surrounding the huge dam.

Approve pay raises in road bureaus

At the request of the State Highway and Public Works Commission, the North Carolina State Advisory Budget Commission on Dec. 27 revised upward its salary classifications for skilled and unskilled highway department employees, with the maximum salary increases going to location and construction engineers, designers, draftsmen and maintenance workers.

The increases were approved after the highway commission declared that because of low salary classifications it was having trouble filling many key posts in connection with the state's postwar highway construction program and that it could not compete with private industry in hiring skilled workers.

Under the new plan, engineers or other skilled workers with the necessary experience may be employed at the maximum salary offered by the state, instead of having to start at the minimum or near minimum scale, which was the practice previously followed.

In granting the maximum salary increases to engineers, designers, draftsmen and skilled and unskilled maintenance workers, the budget commission acted in response to a complaint by the highway department that its force of such workers had been depleted so badly during the war that it now is entirely inadequate in view of the increased building and maintenance planned under the state's proposed $75,000,000 highway program.

More pay for Missourians

Effective at once, the 1,200 employees of the Missouri highway department are receiving pay increases averaging more than 7.6 percent over their former wages —according to an announcement made by P. H. Daniels, assistant chief engineer. The increases, approved by the highway commission, were the result of a year-long study of pay rates in sub-departments.

"The raises ranged from 2.5 to 9.6 percent," Daniels said, "The increases also will be made available to returning servicemen—in order to place them on a par with other workers in sub-departments."

Labor raises in Washington State

A general wage increase averaging about 20 cents an hour for building and heavy construction workers in Oregon and the five southwestern Washington counties has been agreed upon by representatives of the Associated General Contractors and the Oregon State Building Trades Council. The agreement is subject to approval by the federal Wage Adjustment Board. It will raise the hourly pay of common laborers from the present 95 cents to $1.15 and the pay of journeymen carpenters from the existing $1.37½ to $1.55. Pay boosts for electrical workers, bricklayers, lathers, millmen, sheet metal workers, plumbers, roofers, painters and other building and construction tradesmen range from 15 to 20 cents an hour under the agreement.

Cleveland needs building workers

A plea to former construction workers to consider a return to their usual occupations has been issued by Stuart R. Smith, area director of the United States Employment Service at Cleveland, Ohio, as part of a campaign to provide the building industry with needed craftsmen.

"There is a critical need for skilled workers in certain crafts to complete housing for which materials are available," he said.

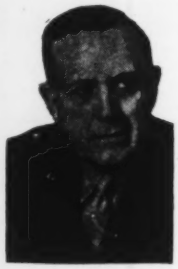
"In addition, some manufacturers of such building materials as brick, concrete blocks, and tile are asking their former employees to return to the jobs which they left during the war.

"Building construction workers should keep in touch with their union officials."

Maj. Gen. McCoach joins Tompkins organization

Maj. Gen. David McCoach, Jr., chief engineer, Mediterranean Theater of Operations during the past year will become vice-president of the Charles H. Tompkins Co., construction engineers of Washington, D. C., immediately on approval of his requested retirement from active military service.

General McCoach, a West Point graduate in 1910, has served continuously for the past 39 years in the Corps of Engineers. His many assignments included those of: assistant to the president of the Mississippi River Commission; district engineer at Detroit and New York; assistant to the Chief of Engineers; commanding general of the 9th, and later the 6th, Service Command; engineer commissioner of the District of Columbia, and his war assignments.



General McCoach

He recently served as War Department representative in charge of Montgomery Ward & Co. properties.

Contract letting forecasts re-start on Davis Dam

H. F. Bahmeier, left, engineer in charge of construction of Davis Dam for the Bureau of Reclamation, congratulates T. L. Terry, construction engineer for Utah Construction Co., on his firm's successful $21,462,505 bid for completing Davis Dam, near Kingman, Ariz. (ENR Jan. 3, vol. p. 10).

The project originally was started by the same firm in 1942, but halted by war restrictions. Biggest undertaking in the southwest since Boulder Dam, the earth-and-rock fill dam will form a reservoir with a capacity of 1,940,000 acre-ft. Dam crest will be 138 ft. above the river bed.

Water released from Boulder Dam, 67 miles upstream, will be stored at Davis for re-regulation and release according to downstream needs, under terms of the U.S.-Mexico water treaty. Provisions of the treaty are given in ENR, Jan. 25, 1945, Vol. p. 123.

Threaten court suit on Houston sewage

Reported pollution of Brays and Simms bayous near Houston, Tex., recently brought a threat from Dr. George W. Cox, state health officer, to ask a court injunction against Houston if the city does not correct the condition in "a reasonable length of time."

Dr. Cox said he would ask the injunction under the new Texas sanitary law which stipulates that approved Texas Health Department methods must be used to dispose of sewage in populous districts. Among the approved methods of disposal are approved privies and chemical toilets, and properly managed sewers and treatment tanks.

Charge "underdesign"

In a pollution survey report on Brays Bayou, made by Frank Metyko of the U. S. Public Health Service, it was charged that "long-term underdesign" was one of three principal causes for the present bayou pollution. Included in this "underdesign" were: inadequate sewer and disposal facilities; industrial wastes, and infiltration from illegal connections and cracked pipes.

The report recommended that a regional sanitary authority be formed to direct all sewage and water activities for the district and the creation of adequate zoning laws so that no future costly mistakes of "underdesign" would be made. As an example of "underdesigning," the report warned that the collecting sewer mains in Houston's planned sewer disposal facilities expansion program might prove to be only 50 percent adequate in residential areas when the city's growth made future expansion of the sewage disposal facilities necessary. To eliminate this danger, the report recommended the use of larger sewer pipes in the city's planned program with a capacity of a minimum 4,000 gallons daily per acre in residential areas instead of the existing basic design rate of 2,000 gallons.

Meanwhile, Houston has prepared a schedule of $2,325,000 worth of sanitary sewer work which it believes will correct the Brays Bayou pollution and which it hopes to complete within a year.

Merrimack River clean-up

Governor Maurice J. Tobin of Massachusetts has proposed cleaning the Merrimack River of pollution and establishing along its banks a highway, park and recreation system which it is estimated, would cost over $20 million.

The estimate was given by Thomas A. Berrigan, chairman of the Merrimack Valley Sewage Commission, after a meeting at which the Governor's proposal was advanced.

The communities that would be affected would include Amesbury, Andover, Chelmsford, Dracut, Groveland, Haverhill, Lawrence, Merrimac, Methuen, Newburyport, North Andover, Salisbury, Tewksbury, Tyngsboro and West Newbury, Mass.

Large loan approved for Melrose Houses, N. Y.

Herman T. Stichman, New York State Commissioner of Housing on Dec. 29, cleared the way for construction of New York City's eleventh postwar state-aided low-rent housing project by formally approving the application of the New York City Housing Authority for a maximum loan of $8,971,600 to construct Melrose Houses in the lower Bronx. The figure includes a margin of safety to provide for unseen contingencies. Also included is $2,600,000 to acquire the site, demolish existing structures and relocate present tenants.

Extending from Morris Ave. to Courtlandt Ave.—a distance of about 1,000 feet—and from East 153 St. to East 156 St., the project will house 1,160 families, or an estimated 4,500 persons. It will replace more than 1,000 dwelling units and an additional number of commercial structures on the site, most of which are old and substandard.

Seeks new water intake on Niagara River

Testimony to show that the west branch of the Niagara River is subject to pollution from industrial wastes and sewage equal at times to pollution in the east branch, was presented by the town of Tonawanda, N. Y., at a recent hearing before the New York State Waterpower & Control Commission in Buffalo, N. Y.

The town is seeking permission from the commission to build a water intake in the east branch of the river for its proposed $1,700,000 water plant. The State Health Department is opposed to the east-river location because of pollution and has recommended that the intake be placed in the west branch, which the health officials asserted at a previous hearing, is less subject to pollution.

Newell L. Nussbaumer, consulting engineer for the town, declared that industrial waste and turbidity have also caused trouble in the west branch intake of the Grand Island water system.

In response to a question from Deputy Attorney General Edward Ryan, who is acting as counsel for the state health department, Mr. Nussbaumer estimated that it would cost the town of Tonawanda $2,700 more per year to pump water across Grand Island to a filtration plant in that township. In addition, he said, $3,000 a year depreciation would have to be charged off on 5 miles of pipeline.

R. G. LeTourneau Co. photo

Speed work on California flood control projects

Seeking to have the facilities in operation before next spring's floods, contractors for the U. S. Engineer Department are rushing work on the Lytle-Cajon Creek project near San Bernardino, Cal.

Heavy earthmoving equipment above is working on a relocation of the Lytle Creek bed, between Colton and San Bernardino. When completed, the new channel will be a concrete-lined canal, 27 ft. deep and 40 ft. wide at the bottom.

Handling hard-to-load loose, silty sand which tends to bulldoze ahead of the scraper blades, the contractor, Clyde Wood of Los Angeles, uses water wagons to wet down the cut and the hauling ramp.

NEWS IN BRIEF

In telegraphic form, here are latest news developments on the engineering and construction front during the week.

Highways—*Oregon* approved a $35,000,000 budget for 1946. . . . *Colorado's* General Assembly appropriated $3,500,000 to match federal-aid highway funds. . . . *Ohio* submitted plans to the PRA calling for 1,290 mi. of freeways within the state. . . . *Georgia* considered a $15,454,000 system of expressways as approaches to metropolitan Savannah. . . . *Illinois* will build a new bridge over Rock River connecting Sterling and Rock Falls. . . . *Arizona* business men and city officials formed the Arizona Statewide Highway Planning Committee to further planning. . . . *South Carolina* considered a $1,400,000 rural highway construction program. . . . *Arkansas* announced approval of a $6,320,000 federal-aid highway program. . . . *Kentucky* called for bids on $2,375,000 in highway work.

Water Supply—*Jacksonville, Fla.*, will supply water service to new subdivisions just outside city limits. . . . About $200,000 will be expended on improvements to water systems at *Pine Bluffs, Ark.* . . . *Normal, Ill.*, will install a water-softening unit. . . . *Chilliwack, B. C.*, plans spending $160,000 on water mains. . . . *Emporia, Kan.*, will spend $200,000 to improve its water system. . . . *Cincinnati, Ohio*, feared it would lose several new industries unless more adequate water service is made available.

Construction—An 800-car, $700,000 garage is planned for downtown *Cincinnati, Ohio*. . . . *Scott County, Iowa*, construction men said more than $10,000,000 in construction work is planned there. . . . W. S. Dickey Clay Manufacturing Co. plans a $1,000,000 plant at *Pittsburg, Kan.* . . . A $1,000,000 medical arts building will be built in downtown *Portland, Ore.* . . . The *Cambridge Mass.*, Steam Corp. announced it would build a $3,000,000 steam plant. . . . San Joaquin County, Calif., planned a 12-story courthouse at *Stockton, Calif.* . . . Sheffield Steel Corp. planned a $5,000,000 three-year building program at its *Kansas City, Mo.*, plant. . . . Pacific Coast Aggregates, Inc., will spend $1,420,000 on its plants and buildings at *Oakland, Fair Oaks, Daly City, Calif.* . . . The Minnesota Mining and Manufacturing Co. will erect a $1,500,000 plant near *Little Rock, Ark.*

Miscellany—*Seattle, Wash.*, voters will decide whether or not there will be $13,500,000 of bond issues for schools and a Public Safety building. . . . Urging better planning, *Cleveland, Ohio*, Chamber of Commerce called for a halt in the city's proposed $68,000,000 capital improvement program. . . . *Indianapolis, Ind.*, received $16,000 in federal funds to aid in planning flood control works. . . . *North Carolina's* Ports Authority has asked a federal advance of $90,000 to conduct surveys of the state's several major seaports.

Calendar of Meetings

NATIONAL

Canadian Construction Association, annual convention, Fort Garry Hotel, Winnipeg, Man., Jan. 14-16.

American Road Builders' Association, 1946 annual meeting and convention, Stevens Hotel, Chicago, Ill., Jan. 14-17.

American Society of Civil Engineers, annual meeting, Commodore Hotel, New York, N. Y., Jan. 16-18.

Highway Research Board, Oklahoma City, Okla., Jan. 25-28.

Associated Equipment Distributors, 27th annual meeting, Edgewater Beach Hotel, Chicago, Jan. 28-31.

American Association of State Highway Officials, Oklahoma City, Okla., Jan. 29-Feb. 1.

American Concrete Institute, 42nd annual convention, Hotel Statler, Buffalo, N. Y., Feb. 18-21.

Associated General Contractors of America, Inc., Chicago, Ill., Feb. 18-22.

REGIONAL

Associated General Contractors of America, Inc., Kansas City Chapter, Kansas City, Mo., Jan. 16.

Colorado Society of Engineers, 30th annual convention, Shirley-Savoy Hotel, Denver, Colo., Jan. 31-Feb. 2.

Wisconsin Road Builders' Association, annual meeting, Plankington Hotel, Milwaukee, Wis., Feb. 6-7.

Ontario General Contractors Association, annual convention, King Edward Hotel, Toronto, Canada, Feb. 8.

Ohio Society of Professional Engineers, annual convention, Akron, Ohio, Feb. 14-15.

Minnesota Federation of Engineering Societies, victory convention, Hotel Radisson, Minneapolis, Minn., Feb. 21-23.

Ontario Good Roads Association, annual convention, Royal York Hotel, Toronto, Canada, Feb. 26-27.

Ontario Roadbuilding Association, annual convention, Royal York Hotel, Toronto, Canada, Feb. 27.

Michigan Highway Engineering Conference, Grand Rapids, Feb. 26-28.

Protest toll proposal for New York Thruway

Protesting the recent proposal by Governor Thomas E. Dewey of New York for the establishment of tolls on New York's proposed "thruway" scheduled to go into construction shortly, (*ENR* Dec. 13, 1945, vol. p. 773) the New York State Automobile Association last week said that revenue from such tolls would not be necessary to finance the work.

In a letter signed by Wiliam J. Gottlieb, president of the association, the group said that the total estimated cost of the road—$202,000,000—calls for an expenditure of about $40,000,000 annually over a period of five years. This total, the group said, is "well within" the means of the state. Mr. Gottlieb said that the state's share of revenue from current motor vehicle and gasoline taxes will average (conservatively) $80,000,000 per year, in addition to about $33,000,000 yearly to be allotted to the state as federal participation in road's construction.

Another point stressed by the association was the "need to keep faith with motor taxpayers."

"Nearly 2,000,000 passenger cars are currently registered by residents of New York State," the letter said. "Only a fraction of the revenue which the state has collected from motor vehicle sources has been spent for highways. For years the state has broken faith with its motor taxpayers."

Urge pollution control organization in Virginia

Enactment of legislation to set up a state pollution control board to enforce necessary measures has been recommended to the Virginia state legislature by that body's advisory council.

The major points of a proposed bill included:

Establishment of a pollution control board to supervise the work of competent men employed by other state departments dealing with pollution problems in the state's rivers and streams; existing industries would be required to take steps to treat their effluents properly, and the same principles would be applied to municipalities; the pollution board, in cooperation with the State Health Department, would be charged with passing on the merits of plans for new sewage disposal plants.

The group pointed out that the proposed bill would work minimum hardships, since it provides that existing industry and municipal plants be given sufficient time to correct such abuses as may be set out in the new code.

Maj. Gen. Farrell returns to New York State post

Major General Thomas F. Farrell, on military leave since Feb. 1, 1941, and recently concerned with the operation of the Atomic Bomb project "on the scene" in the Pacific, last week returned to his post as chief engineer, New York State Department of Public Works.

After service during the first World War, Gen. Farrell resigned from the army in 1926 to become Commissioner of Canals and Waterways for New York State, becoming chief engineer for the public works department in 1930. He rejoined the corps of engineers in 1941 as a lieutenant-colonel. Subsequently, he served as division engineer, Middle-Atlantic Division, Baltimore, Md., and chief of the construction division, Office of the Chief of Engineers, at Washington, D. C.

Gen. Farrell

On Nov. 16, 1943, he became Chief Engineer, Services of Supply, China-Burma-India theater (*ENR* March 2, 1944, vol. p. 303) and Commanding General, Construction Service.

He joined the Manhattan Engineer District in February, 1944 as deputy chief. In July, 1945, he personally supervised assembly of the first atomic bomb at a Pacific Island base before its use against Hiroshima, Japan.

In January he was named assistant chief of staff at Supreme Headquarters in the Mediterranean theater and was responsible for staff planning in conjunction with the equipping, training and final direction of operations of all Allied Forces in that theater. He immediately supervised amphibious training for the invasion of Southern France. A citation awarding him an Oak Leaf Cluster to the Distinguished Service Medal for his work in the Mediterranean theater sets forth that "His exercise of sound judgment and personal ability to direct important staff action was a great contribution to the success of the Allied Forces in the Mediterranean Theater of Operations."

Maj. Gen. Daniel Noce named chief of staff, ASF

Maj. Gen. Daniel Noce has been appointed deputy commander and chief of staff of Army Service Forces. A former district engineer at Memphis, Tenn., he succeeds Lieut. Gen. Leroy Lutes who was designated as Gen. Brehon Somervell's successor as commanding general of ASF (*ENR* Jan. 3, vol. p. 2).

Since his return from foreign service last May, General Noce has served as director of plans and operations for ASF and recently was acting chief of staff while General Lutes was acting commander.

General Noce was assigned to Memphis in 1937 and left in 1940 to create and train the Amphibious Engineer Brigades which participated in every major landing in the European, Mediterranean and Pacific theaters of war action.

Halt U.S. condemnation of city's property

The U. S. Circuit Court of Appeals at St. Louis, Mo., last week handed down a ruling forbidding the federal government to condemn city property in Cape Girardeau, Mo., for the construction of a new courthouse and postoffice.

Confirming an earlier decision, the court said that the government's attempt to condemn a public park, county courthouse and public library at Cape Girardeau would amount to governmental interference with the processes of local government.

The controversy arose when the government proposed construction of a $320,000 courthouse. The new building would have been erected on the site of the present civic center, the city, in return, receiving title to the present federal postoffice, plus a monetary consideration.

An heir of the donors of the property intervened on the ground that the property on which the city buildings are located was donated to the city in 1820 for the "benefit of the city's inhabitants" and that the city could not abandon the park or buildings.

Pitometer Co. officers

The Pitometer Co. of New York City, has announced the resignation of Edward S. Cole as president. He will continue his connection with the company as consulting engineer.

The following new officers have been elected: Egbert D. Case, president and general manager; E. Shaw Cole, vice president and chief engineer; and C. R. Bird, vice president and western manager.

Moles name recipients of annual awards

O. W. Swenson and Miles I. Killmer received recognition for outstanding contributions to construction progress.

Oscar W. Swenson, pioneer transcontinental railroad builder, and Miles I. Killmer, now supervising operations on the New York end of the Brooklyn-Battery tunnel, will receive awards "for outstanding contributions to construction progress" given each year by The Moles, New York organization of tunnel and heavy construction men.

O. W. Swenson

Formal presentation will be made at a dinner meeting to be held at the Roosevelt Hotel, New York City, Feb. 6.

By custom the awards are made to one member and one non-member of the Moles organization.

Both men are contractors

Mr. Swenson, 81, is president of Foley Bros., Inc., of New York, railroad builders. Since he joined the Foley organization in 1885, Mr. Swenson specialized in railroad construction for the Canadian-Pacific, Canadian Northern, the Grand Trunk Pacific, and the Algoma Central Railroads.

Mr. Killmer, vice-president and general manager of Mason & Hanger Co., New York contractors, has worked on most of the important under-river tunnels for rail or vehicular transit in the metropolitan district of New York since 1906. These include the several subway tubes linking Manhattan and Brooklyn, the Holland and the Lincoln tunnels under the Hudson River between New York and New Jersey, and the Brooklyn-Battery tunnel now under construction.

Miles I. Killmer

Mr. Killmer's career has been devoted largely to compressed air tunneling.

Past recipients of The Moles Award for construction achievement include Gen. Brehon V. Somervell, chief, Army Service Forces; Vice-Admiral Ben Moreell, Navy Bureau of Yards and Docks; and Frank Crowe, builder of Boulder and other dams.

WASHINGTON HIGHLIGHTS

• ***Not for Engineers***—In passing the bill (H.R. 4129) which will permit the President to reorganize the executive branch of the federal government, Congress specifically wrote into the law that the reorganization plan should not provide for any reorganization affecting any civil function of the Corps of Engineers. The bill provides that the reorganization plan cannot become effective if it violates this restriction.

• ***Road Accident Conference***—President Truman has announced that a Washington conference will be held this spring in an effort to reduce highway accidents. He has asked that Maj. Gen. Philip B. Fleming, Administrator of the Federal Works Agency, preside and arrange for the program at the conference. Concerned because of the great increase in traffic accidents since the end of the war, the President hopes to bring together members of the state highway departments and municipalities who are in charge of safety on the nation's highways.

• ***Columbia Valley Authority***—Identical bills (S. 1716 and H.R. 5083) creating a Columbia Valley Authority were introduced in the Senate and House Dec. 20. These measures add to the long list of valley authority bills already before Congress. The proposal is to set up a corporation known as the Columbia Valley Authority directed and controlled by a board of three directors. These men would be appointed by the President with the approval of the Senate and would receive an annual salary of $15,000. All other officials and employees of the authority will be selected by the corporation, and all matters of policy would be determined by the board of directors. Three months after the bills become law the corporation would be given control of the Bonneville Project, including Bonneville Dam, the Columbia Basin Project, including Grand Coulee Dam, and the Hungry Horse, Umatilla and Snake River projects. These latter developments would include Hungry Horse Dam, McNary Dam and other major structures. The corporation would be permitted to operate the facilities taken over through the previous operating agencies, that is, the Bureau of Reclamation and the Corps of Engineers. Unexpended balances of the appropriation for the Department of the Interior and the War Department for the construction, operation and maintenance of the projects just mentioned and the other facilities to be taken over would be transferred to the corporation.

• ***No Parking***—The difficulty of finding automobile parking space in downtown Washington has become so great that Congress will be asked to pass an act requiring downtown property owners constructing new buildings to provide parking space for ten percent of the people expected to occupy the new building. When this proposal was first raised the original plan was to restrict only government construction in this manner.

Chicago subway work is being resumed

The Chicago, Ill., Department of Subways and Superhighways opened bids Dec. 27 on two contracts as the first move to resume construction on Chicago subways interrupted by the war. Kenney Construction Co., of Chicago, was low of eight bidders on a connecting structure between the west end of present Dearborn St., subway and the elevated line at Milwaukee Ave. and Evergreen St., submitting a proposal of $538,460. This does not include cost of steel, which is being fabricated under a previous contract. Citywide Construction Co., Chicago, bid $107,390 as low for waterproofing the Dearborn St. tubes.

Water-borne cement now allowed in Seattle

Shipping to Seattle, Wash., of bulk cement from California for packaging and delivery will be the next project of Henry J. Kaiser's Permanente Cement Co., following amendment by the Seattle Board of public works of the building code to permit use in Seattle of cement transported by water.

Officers of the General Construction Co., Seattle, a Kaiser associate, said construction of a packaging plant and storage facilities will begin at once. Located on Duwamish Waterway, the plant will be built at a cost of "several hundred thousand dollars" by Kuney-Johnson Co., of Seattle. It is not expected to supply in excess of 15 per cent of cement requirements of the region.

Previously, under the Seattle building code, bulk cement could not be brought from points more than 200 miles distant. The new amendment allows use of water-borne cement providing the distance does not exceed 1,000 miles. Bulk cement carriers released by the Maritime Commission will be used.

In response to reader preferences expressed in recent surveys, the Contents page in this and all succeeding technical issues of *Engineering News-Record* will be found just inside the main cover.

JOBS OF THE WEEK

NAVAL ORDNANCE TESTING STATION BUILDINGS, Inyokern, Calif.

Johnson Drake & Piper, Oakland, Calif., have been awarded a contract for a 2-story, office and laboratory building at Naval Ordnance Testing Station, by Bureau of Yards & Docks, Navy Department, Washington, D. C., at $5,060,000.

HOUSES, Portland, Ore.

Sandberg-Asbahr, Portland, will construct 300 houses by day labor. The estimated cost is $1,500,000.

RESIDENCES, San Mateo, Calif.

H. H. MacDonald, San Mateo, will construct 150 residences by his own forces. The estimated cost is $2,000,000.

ASSEMBLY PLANT, Maywood, Calif.

William P. Neil Co., Los Angeles, Calif., has been awarded a contract for auto assembly plant on a 36-acre site by Ford Motor Co., Dearborn, Mich., to cost about $2,000,000. Harry T. Miller, Los Angeles, is the architect.

COMPLETING CONSTRUCTION, Shumaker, Ark.

Bureau of Yards & Docks, Navy Department, Washington, D. C., awarded a contract for unfinished construction at Naval Ammunition Depot, to George A. Fuller Co., New York, N. Y., at about $3,000,000.

PULP and PAPER MILL, Macon, Ga.

Mead Corp., Dayton, Ohio, will construct a pump and paper mill and manufacturing plant by its own forces. The estimated cost is $10,000,000.

Note—Additional bidding and contract news on many projects large and small, including the above items, appear in the Construction News section beginning on page 259.

OBITUARY

William Elmer Malott, 69, an engineer who had worked on the Panama Canal died in Dover, N. J., Dec. 29.

George A. Glass, construction manager for the Merritt-Chapman & Scott Corp of New York, and formerly head of his own firm, the George A. Glass Co., died Dec. 29 at Garden City, N. Y.

Thomas Joseph McGovern, former chief engineer of the Welland Canal and recently head of the T. J. McGovern Co., Ltd. of Toronto, Ont., died Dec. 23.

Hale Houston, 74, professor emeritus of engineering at Washington and Lee University, died at Lexington, Va., Dec. 17.

A. W. Andrews, 61, chief engineer for the Central New York Power Corp., died at Syracuse, N. Y., Dec. 27. With the power company for 28 years, he was a civil engineering graduate of Massachusetts Institute of Technology.

George Frederick Eckhard, 67, dean of the University of Vermont's college of engineering died Dec. 28. He was professor of civil engineering at Pennsylvania State from 1912 to 1915, when he joined the Vermont faculty. He became dean of engineering in 1932.

Samuel Dunbar Mangum, 66, died in Collierville, Tenn., Dec. 22. He was a well-known road builder and vice-president of the Sensibar Engineering & Paving Co. of Chicago, Ill.

Charles Francis Chase, 80, bridge engineer and chairman of the board of the Berlin Construction Co., New Britain, Conn., died Dec. 28. He retired as president in 1944, but remained as chairman.

Charles Neeld, civil engineer of Pittsburgh, Pa., died in Annapolis, Md., Dec. 23. Mr. Neeld, who supervised the construction of the lock gates of the Panama Canal, was general manager of the Pittsburgh plant of the McClintic-Marshall Construction Co., but left that firm to organize his own company, specializing in bridge construction.

Eugene Harold Moss, 42, Raleigh, N. C., consulting engineer, died Dec. 27. From 1928 to 1938, he was superintendent of water and sewerage plants at High Point, N. C., and for the next five years held a similar position at Greensboro, N. C. He moved to Raleigh in 1943 as sanitary engineer for U. S. Area No. 4.

George G. Ford, retired engineer of Chapel Hill, N. C., died Dec. 26. For 20 years he was connected with the North Carolina Highway Commission as a bridge engineer and inspector.

Charles Lamar Potts, 60, Charlotte, N. C., hydraulic engineer, died Dec. 25. During the last four years he had been connected with the Laurinburg-Maxton, N. C., Army Air Base and was associated with Metcalfe and Eddy, consulting engineers, during the construction of the base.

Forrest Milton Towl, 81, retired chairman of the board of the Southern Pipe Line Co., died Jan. 3 in Brooklyn, N.Y.C. Mr. Towl was graduated from Cornell University in 1886 with a civil engineering degree.

J. H. Brillhart, 65, president of Ft. Worth Structural Steel Co., and a civil and structural engineer, died Dec. 17 in Ft. Worth, Tex. He was a past president of the Texas Section of American Society of Civil Engineers and was the organizer of the Technical Club of Ft. Worth.

Glen Brown, 56, Huntington, Ind., for the last six years county highway supervisor, died Dec. 24.

James H. Moorhead, 80, retired Cleveland building contractor, died Dec. 28.

Earl Van Nostrand Guyther, sanitary engineer at Brooks Field, San Antonio, Tex., died Dec. 10.

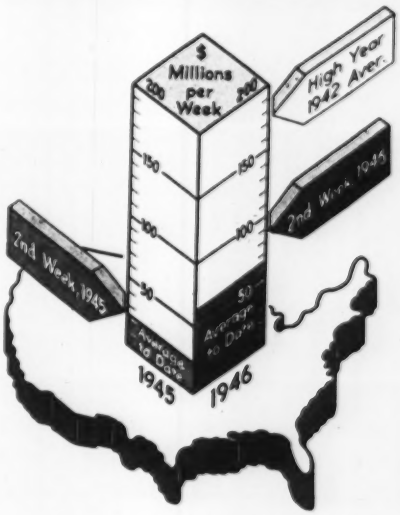
Plan elevated highway to ease Seattle traffic

The Seattle, Wash., city council recently passed a resolution clearing the way for condemnation of property for construction of an elevated highway on Alaskan Way to remedy increasingly acute motor traffic problems by providing a through route from the downtown district to the city's outskirts.

When completed, the elevated roadway will be a double-deck structure, with four lanes for traffic on both levels. The lower deck only will be constructed in initial phases during 1947-48, at an estimated cost of $3 million. The route will start at Dearborn St., on First Avenue South—main highway into the city from the south—and extend to the junction of Virginia St. and Armory Way on the city's waterfront; thence to First Ave. and Wall St., where the elevated section ends.

The roadway, however, will be continued to Aurora Ave., main highway leading to the north.

CONSTRUCTION ACTIVITY



As Reported this week to ...
Engineering News-Record

CONTRACT VOLUME

Continental U. S. Only (Thousands of Dollars)	Week of Jan. 10* 1946	Cumulative 1946 (2 wks.)	Cumulative 1945 (2 wks.)
Federal	$7,499	$9,678	$19,524
State & Mun.	16,834	31,308	9,565
Total Public	24,333	40,986	29,089
Total Private	63,638	90,280	22,611
U. S. Total	**$87,971**	**$131,266**	**$51,700**

* 7-day week.

WHERE CONSTRUCTION ACTIVITY ORIGINATED THIS WEEK

Type of Work	Dollar Volume (Thousands) This Week	Cumulative 1946 (2 wk.)	Cumulative 1945 (2 wk.)
Waterworks	$490	$705	$1,331
Sewerage	1,283	1,597	1,557
Bridges	1,989	5,049	3,130
Highways	9,160	13,494	6,264
Earthwork, Waterways	1,773	3,280	847
Buildings, Public	6,615	13,134	11,290
Industrial	24,981	32,524	17,770
Commercial	35,370	53,514	1,199
Unclassified	6,310	7,969	8,312

NOTE: Minimum size projects included are: Waterworks and waterway projects, $15,000; other public works, $25,000; industrial buildings, $40,000; other buildings, $150,000.

NEW PRODUCTIVE CAPITAL

	Cumulative 1946 (2 wk.)	Cumulative 1945 (2 wk.)
NON-FEDERAL	New	$8,947
Corporate Securities	data	95
State and Municipal	not	8,852
RFC Loans	available	.....
REA Loans		.....
Fed. Aid Highway		.....
FEDERAL		77,137
Total Capital		86,084

ENR INDEX NUMBERS

Index Base = 100		1913	1926
Construction Cost	Jan. '46	316.32	152.05
Building Cost	Jan. '46	242.23	130.94
Volume	Dec. '45	163	71

EDITORIALS

VOLUME 136 NUMBER 2

January 10, 1946

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Worthwhile Authority

IN THE DISPOSAL of surplus construction equipment the Office of Surplus Property is finding many local government organizations handicapped by the inability of their representatives to pay at once for the desired units. For example, most cities require specific approval for each purchase from their governing boards. Although provisions are made to hold equipment for short periods, this adds to the burden of the disposal staff. Not infrequently by the time a representative has obtained the necessary purchasing authority the equipment has been sold. In view of these hindrances to rapid selling, the disposal agency considers especially worthwhile the recent action of the city council of Seattle, Wash., in passing an ordinance setting aside $125,000 for the purchase of surplus supplies and granting City Engineer C. L. Wartelle broad powers to pay on the spot for desired purchases (*ENR* Dec. 6, 1945, vol. p. 753). Because of the volume of equipment yet to be sold by the Office of Surplus Property, and since earlier delivery of all types of construction equipment through regular channels appears rather distant, the purchasing agents of many government groups might find it worthwhile to obtain similar authority. Much quicker disposal of the equipment and a large financial saving to the nation could result.

Bridge Railing Design

PROGRESS made in recent years in developing railings from inefficient and frequently ugly elements of a bridge into an efficient safety device that at the same time has a pleasing appearance is recorded elsewhere in this issue. The railings illustrated or described serve as another example of the advantages to be gained from appraising experience against a background of engineering knowledge. Combinations of curbs and railing that have been devised in this manner are able to withstand the forces applied to them due to normal accidents with a minimum of injury to both the vehicle and the bridge. Also, a variety of satisfactory forms have been evolved to meet varying conditions. Nor has appearance been neglected. Here again, as in many other types of structures or structural elements, simple, functional forms have been found to be most satisfactory. In this connection, however, one is lead to question the design in the article in which the slope of the upper and lower surfaces of the rail is varied so that the planes converge at the theoretical location of the eye. The objective is to reduce the interference of the railing with vision, but the slight improvement hardly compensates for the increased construction difficulities from complicated formwork. Others may find details of some of the other designs to question, and thus bridge railing progress will continue to be recorded.

Safety Despite Danger

CONSTRUCTION for the most deadly and dangerous of weapons, the atomic bomb, has been accomplished with accident rates so far below the average that the National Safety Council's award for distinguished service to safety has been presented to the Manhattan District of the Corps of Engineers in recognition of the accomplishment. In accepting the award in a broadcast program Maj. Gen. Leslie Groves, head of the district, passed the credit to the universities and the industrial and construction organizations who participated in the achievement. In the final analysis, it belongs to those individuals in all phases of the endeavor who sold the idea of working safely to the many thousands of workmen engaged and to the workmen themselves who put the precepts into practice. Here again, it has been shown that safety can be attained on construction by those who are willing to work for it. Every construction job should benefit by the example set by the biggest construction job of the war.

Hall of Wonders

THOSE WHO HAVE CLAIMED that the possibilities of reinforced concrete go far beyond current practice in this country will find much to support their view in the new Quitandinha Hotel being built at a mountain resort 70 miles from Rio de Janeiro, Brazil. As Arthur J. Boase points out in an article in this issue, it contains arches, a 152-ft. diameter dome, circular continuous girders, slabs reinforced in a wide variety of ways, 100-ft. span rigid frames, suspended ceiling slabs and cantilever balconies.

Design principles and practices on which Brazilian engineers rely in creating these various structural forms have been reviewed previously by Mr. Boase in the April 19, June 28 and Oct. 18, 1945, issues of this journal, and an article on the design of the great Quitandinha dome will be published in the near future. This great structure is indeed a hall of wonders in the field of reinforced concrete, and American engineers can study its details with much profit, and no little enjoyment in the accomplishments of South American members of their profession.

Standards for Interstate Highways

SHOULD this country undertake at this time to build a nationwide system of interstate super-highways to a *single set* of design standards, or should there be two sets, an ideal standard and a minimum standard? We raise that question as a result of a study of the minimum standards that already have been set for the projected National System of Interstate Highways, which are given on p. 131 of this issue. In posing the question there is no intent to criticize the work done by committees of the American Association of State Highway Officials or by the National Interregional Highway Committee, for these committees were, in effect, instructed to recommend a single nationwide set of standards. The question is asked for the purpose of suggesting the desirability of having the Public Roads Administration or the AASHO carry their studies to the point of recommending a second set of standards considerably superior to the minimums adopted by the AASHO last year.

Creation of a 40,000-mile National System of Interstate Highways was authorized by Congress in the Postwar Federal-Aid Highway Act of 1944, and work on some sections of the system will begin actively this year. Part of the system will be new construction and part will be reconstruction of existing roads. In densely populated areas these new traffic facilities will be multiple-lane superhighways, but by far the greater mileage will be two-lane or four-lane divided highways, laid out to permit expansion to superhighways as traffic demands increase.

This system is expected to provide modern highways between all major centers of population, and to be adequate for the next 20 years. Consequently, the standards to which it is built need to be of a high order. This fact was recognized by the National Interregional Highway Committee appointed in 1941 by the late President Roosevelt, but in undertaking to find standards for such a system that would be acceptable nationally the committee appears to have scaled down its final recommendations from standards that it would have set had it been recommending design standards for superhighways to serve only densely populated regions. And last year, when the AASHO came to select the minimum standards that actually are to be used for the interstate system as now approved, its committees found that still further scaling down or qualification of the interregional committee's standards was necessary to obtain nationwide acceptance.

The net result is that the minimum standards set for the system that is expected to provide adequate intercity and interstate highways for at least the next 20 years are little different from those applied to the better highways of the immediate prewar years. Conceivably, there may be nothing wrong with such a condition; the prewar standards may have been so close to the ideal as to call for no major changes. But we doubt that many highway engineers would support such a view. Higher standards appear to be indicated for those parts of the new system that will carry large volumes of traffic right from the start; yet the state highway departments now have no clear guide as to what those standards should be. Any department that believes that all or part of the interstate system within its borders should be built to standards higher than the prescribed minimums has to adopt its own standards. Hence the need for a second set of standards, which might be called the ideal standards for the interstate system. The desirability of having these standards set high appears obvious.

Promulgation of such standards by the Public Roads Administration or the American Association of State Highway Officials would, we believe, do more to produce uniformity than will the present plan for setting only minimum standards, because the states in which the need for superhighways is most urgent would in all probability immediately adopt the higher standards or standards very close to them.

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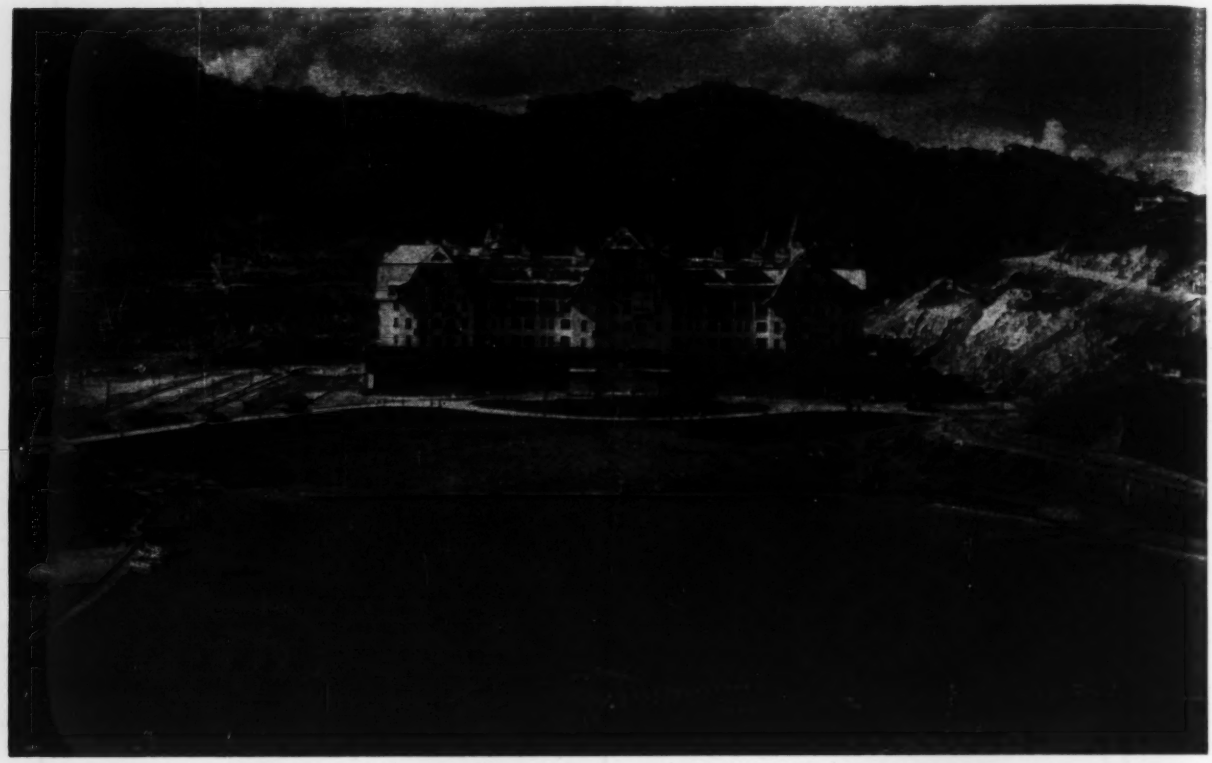


Fig. 1. Quitandinha Hotel, destined to be one of Brazil's most popular warm-weather resorts, fronts on an artificial lake.

Brazil's Wonder Hotel and Casino

Arthur J. Boase
Manager, Structural Bureau, Portland Cement Association

***Contents in Brief**—One of the most unusual structures observed by Mr. Boase during his tour of South America under the auspices of Engineering News-Record is Quitandinha, a warm-weather resort hotel now under construction near Petropolis, summer capital of Brazil. Among the unique features noted are a roof-top landing field for helicopters, a 152-ft. reinforced concrete ribless dome, 100-ft. rigid frames and concrete trusses.*

PETROPOLIS, a small city in the state of Rio de Janeiro, is known as the summer capital of Brazil. It is here that Don Pedro II, the last ruler of Brazil and the man who is sometimes referred to as the Lincoln of that country, because of his activity in freeing the slaves, maintained his palatial summer home. However, it was structural engineering curiosity rather than historical connotations that prompted my visit to Petropolis. Near here there is under construction a hotel development whose every feature fits the term "colossal."

One may travel from Rio de Janeiro to Petropolis, a distance of about 70 mi., by means of a narrow-gage railroad, which at one place operates over terrific grades as a cog railway, or one may make the trip over a thoroughly modern highway by automobile.

The concrete bridges along this latter route would make a study in themselves, for their designs are unique and their slenderness is comparable to anything seen in Switzerland. The road is not new nor are the bridges. Since they were designed for traffic undoubtedly much lighter than is traveling over them today, I suspect that a number of these bridges have required strengthening to meet present day traffic conditions.

I made this trip both by train and auto, and since gasoline was not available, recourse had to be made to the ever present gasogenio (charcoal burner).

Petropolis is in the hills, and one starts climbing shortly after leaving Rio. Although it was winter when I made the trip, the hills were green, and palms and other shrubs were plentiful. But on the outskirts of the city a huge

area was stripped of vegetation to reveal the activities of a major construction operation. This was "Quitandinha," the wonder hotel and casino.

The word *quitandinha* in Portuguese literally means "small produce shop." After having gone through the building, visiting every nook and cranny, one finds it difficult to reconcile the name with what is reputed to be one of the most complicated buildings yet erected in Brazil and most certainly will be its most luxurious hotel.

I visited the job site in the company of Prof. Alves Noronha—the structural engineer responsible for its design—and his class of civil engineering students from the National School of Rio, which included some eight young ladies, all keenly interested in civil engineering. One could not help notice that they carefully inspected every angle of this project and that their questions indicated a good understanding of the problems involved.

Hotel being built when visited

At this time part of the edifice was completed and decorated. The major portion of the building, however, was still under construction, as was the artificial lake, water supply facilities, sewage disposal system, and winding highways and streets that will serve cottages to be erected later as part of this enormous project.

Cost of the hotel and casino building was at that time estimated at $7,000,000. The estimate had started much lower and had been revised upward many times. Some people closely connected with the project were quite positive that the end was not in sight and felt that the owner would be lucky to get out at $10,000,000. Cost of the cottages surrounding the main building is not included in the above estimate, since their erection will be undertaken as a separate project.

Lake necessary for gambling?

The story of the artificial lake is interesting. I was told that in Brazil it is contrary to the law to have a gambling casino not located near a body of water. Some people say that this law was put into effect to keep gambling out of the business sections of cities.

However, there may be other reasons for this law. Rio, a city of about 1,800,000, and Sao Paulo, with a population of 1,300,000, are natural rivals politically and in every other way. Rio, of course, is located on one of the most beautiful bays in the world, and Sao Paulo is some 20 mi. inland. There are many people who insist that the law regarding casinos by the water was put through on a political basis and for the benefit of Rio.

The architectural style of the hotel is Norman. Anyone who has visited the northern coastal part of France and has seen the small, beautiful buildings, which are the originals in this type of architecture, has difficulty adjusting his thinking to a building the size of this hotel in the same style.

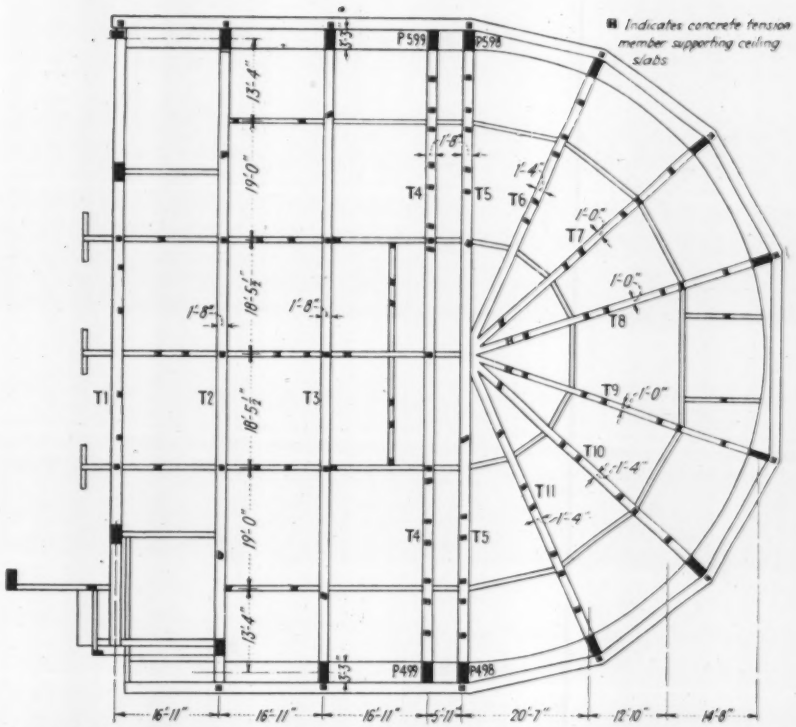


Fig. 2. Roof framing plan of grill indicates tremendous size of room. Truss T5 supports six half-trusses cast monolithically with it.

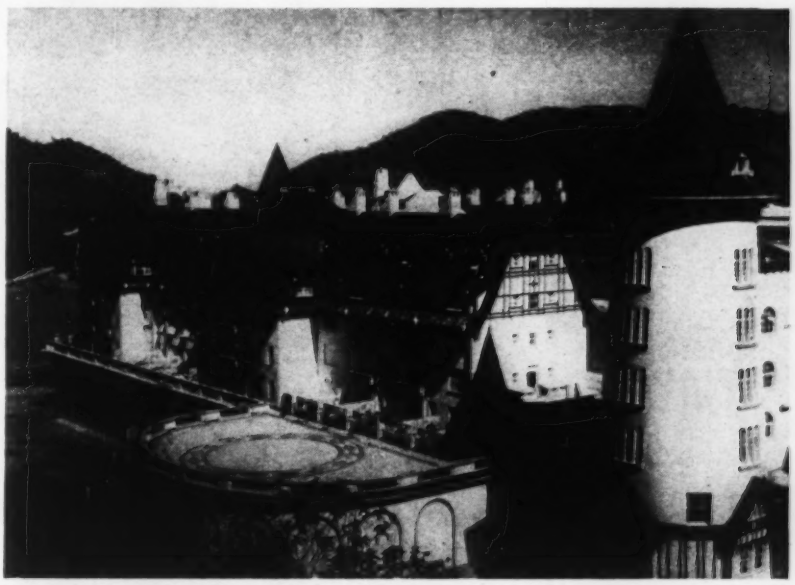


Fig. 3. Quitandinha provides a tile-paved landing platform for helicopters. Tower is stuccoed reinforced concrete with cast-in-place walls 2.8 in. thick.

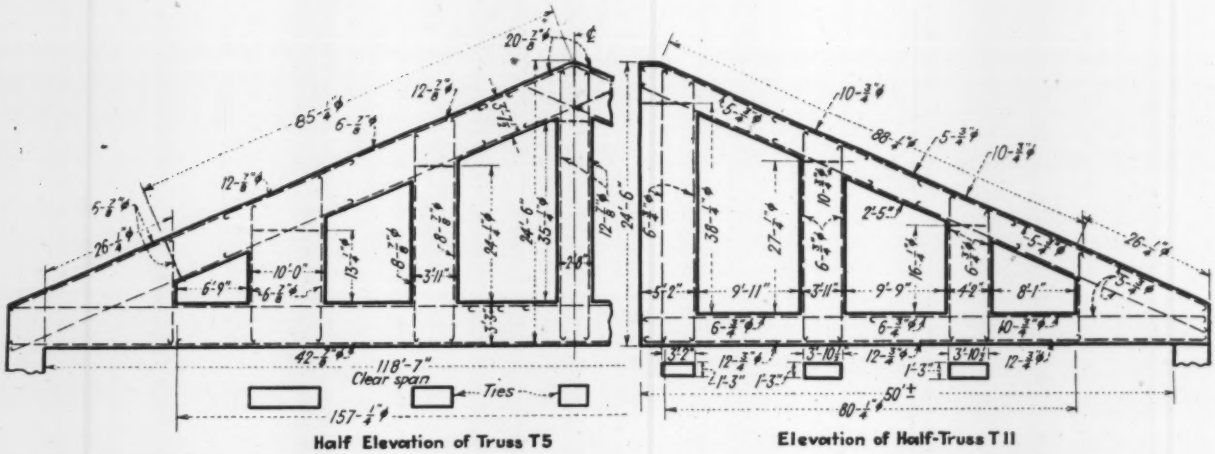


Fig. 4. Vierendeel trusses T5 and T11, supporting roof over grill room and from which are suspended decorative concrete slabs, were designed through use of four moment equations method.

It is even more disturbing to visit the finished interior and try to become used to the bright colors of the broad-striped wallpaper in the bedrooms, gay-colored carpets and very modern decorations and finishings. But it is not difficult to imagine that the guests will be amply entertained when one is shown the many dining rooms, swimming pools, gambling pavilion, ice skating rink, theater, grill-room, helicopter landing platform and every other conceivable luxury known to the hotel and entertainment world.

Fig. 5. Decorative concrete slabs forming ceiling of grill room are suspended from roof trusses. Note class of workmanship.

The frame of the building is reinforced concrete. The walls follow typical South American practice—8 in. of hollow tile, stuccoed. However, it departs from the "usual" from this point on.

Certainly a roof designed for the landing of helicopters is novel. An ice skating rink with rigid frames of 100-ft. span supporting the upper stories of the building is not common, nor are reinforced concrete trusses and half-trusses over the grill-room something one sees every day. A reinforced concrete ribless dome of 152-ft. span, the longest in South America and possibly in the world, in which prestressing has not been employed, is also incorporated. These are only a partial list of the intriguing things about this building.

Dome roofs gambling room

One walks down the very impressive grand hall from the main entrance and descends a few steps into a spacious, well-lighted room where the "big gambling" will be done. The overhead sky-like dome, which had already been finished at the time of my visit, is painted a deep blue and the lantern is decorated in silver and is lighted indirectly. All other decorative features have a silver finish, and this combination, together with the green felt-covered tables, is most attractive.

The floor of the salon under the dome is a 12-in. thick slab, circular in area and supported on two concentric circular beams. The dome is of 6-in. uniform thickness. The periphery beam, 2 ft. 7½ in. wide and 3 ft. 7½ in.

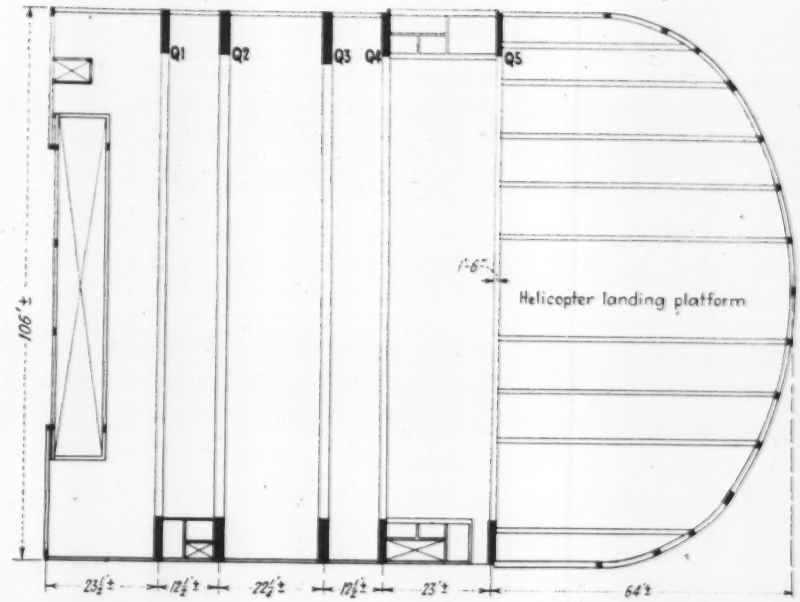


Fig. 6. Framing plan over ice skating rink and under helicopter landing platform. Rigid frames are marked Q1 to Q5.

deep, has a centerline radius of 77 ft. 5 in. and the inner beam, 2 ft. 8 in. wide by 2 ft. 4 in. deep, has a centerline radius of 36 ft. 1 in.

At the apex of the dome there is a lantern of 7-ft. 0§-in. radius. Preliminary investigations disclosed that the strains at the edge of this lantern were not great, and in the final calculations the presence of the lantern was neglected. A rectangular beam 18 in. wide and 15 in. deep, reinforced with ten §-in. round bars, was used as the reinforcing for the lantern.

This dome, from a structural point of view, is undoubtedly the most interesting part of the whole structure. Its design and details will be more fully described in a subsequent article.

Unique framing over grill room

While design of the dome must have been a fascinating adventure in reinforced concrete, it is not much more intriguing than the framing over the immense grill-room, which will on completion be one of the most attractive features of this unusual hotel. Typical of South America, dining is to be a main event for every guest. No details have been overlooked, and I was told that a special dining room was to be reserved for the children. Here the furniture and appointments are to be worked out to the scale of the guests—even the waiters will be undersized.

The size of the pretentious grill-room, and more particularly the framing plan of the roof, are shown in Fig. 3. Trusses marked T1 to T5, having a clear span of 118 ft. 7 in., are of the Vierendeel type in reinforced concrete with sloping top chords, and supporting columns have a dimension of 3 ft. 3 in. in the direction of bending. Truss T5 supports six half-trusses, all framing into it at the centerline and cast monolithically with it. General

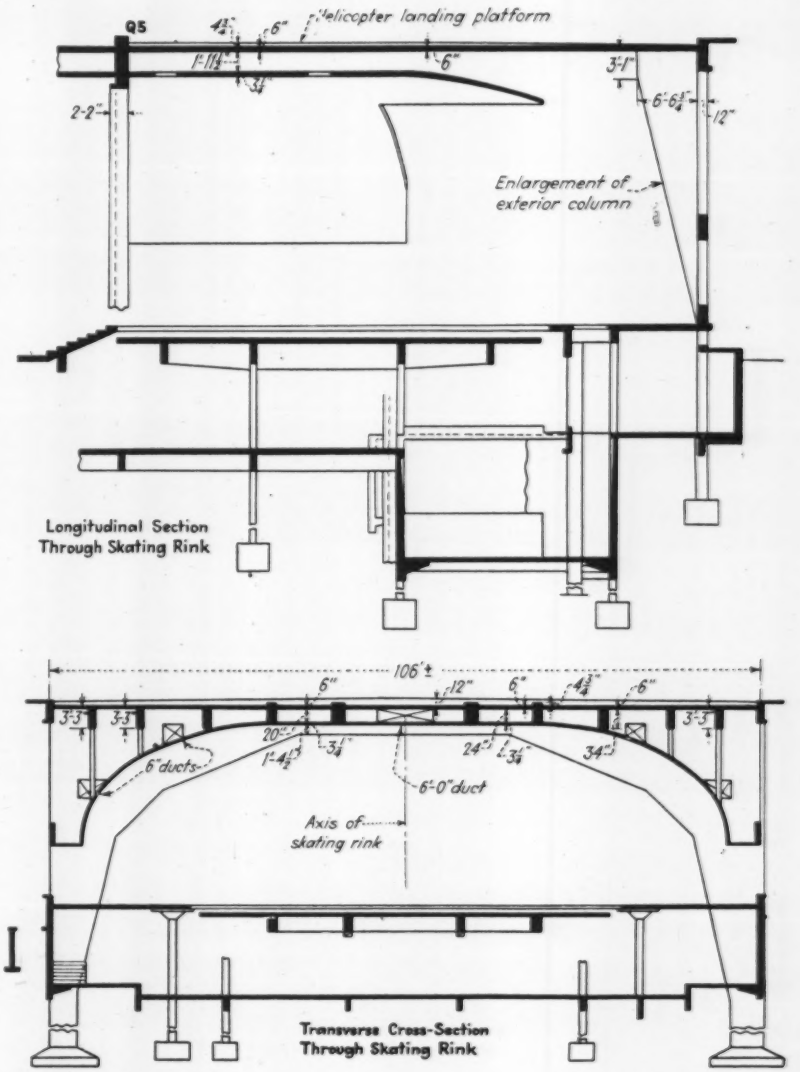


Fig. 7. Sections through skating rink outline rigid frames together with concrete canopy, air conditioning ducts, skating floor and space for embankment of brine pipes.

dimensions and reinforcing detailing used for truss T5 and T11 are shown in Fig. 4; the other trusses are similar.

One interesting feature of the design is the method of analysis—the four moment equations—seldom used in the United States. Those who have used it, however, claim many advantages for it.

Most interesting is the use of concrete slabs in the ceiling (Fig. 5). These concrete canopies, suspended from the roof trusses, were designed as two-way slabs supported on points and are about 4 in. thick. When finally completed, they will be plastered and decorated and will act as vanes to direct the currents of air in the air conditioning system. They will be indirectly lighted.

Helicopter landing platform

The owners of Quitandinha, like all other South Americans, are anticipating a great boom in air travel during the postwar period and have made provisions for patrons flying from Rio and other points in helicopters.

Planes may land on a tile platform (Fig. 3 and 6) attached to the building, which may then be entered as easily as from an automobile. The supporting beams of this platform are of very long span, and a cross section through this floor (Fig. 7), gives some idea of how slender (about 1/19) this construction is, even though the columns are enlarged to reduce the span. The live load assumed in the calculations was about 61 psf.

Also of considerable interest is the landing platform construction. Over the concrete structural slabs, four layers of impregnated felt were mopped with asphalt. On this was spread 0.4 in. of a 1:2 mortar in which were embedded 4-in. thick bricks with butted joints. Another layer of 1:2 mortar was spread 0.4 in. thick on top of these bricks, and 0.8-in. thick ceramic tile were laid with very close joints to form the final finish. Contractors repeatedly told me that with flat roofs in areas with heavy rainfall this was about the best watertight construction they had been able to devise.

Rigid frames over skating rink

Under the helicopter platform and extending well into the main building is an air-conditioned ice skating rink. Rigid frames over the rink, using "bundle" reinforcement, carry three floors, an attic and a sloping roof on five columns (Fig. 8).

One of the most interesting features of these frames is the reduction of section to accommodate air-conditioning ducts. It would seem from this that the term rigid frame is more or less a misnomer. The reduction of section at the centerline would seem to cause the frames to act in this case nearly as a 3-hinge bent.

Many types of problems involved

Quitandinha is not a tall building, but it does cover a large area, and as I went through the job, it seemed that almost every type of building problem was present. Here in one structure were arches, domes, the ever-present curved stairs, circular continuous girders, towers, cantilevered balconies, revolving stage, rigid frames, suspended ceilings of reinforced concrete, flat slabs, one-way and two-way slabs, circular floors and a host of other interesting and many novel design problems. Neither space nor time permit even a fair description of the structure in its entirety.

One thing is certain—the designer has demonstrated not only the flexibility of the material and his confidence in it, but also his wide grasp of the principles of structural design.

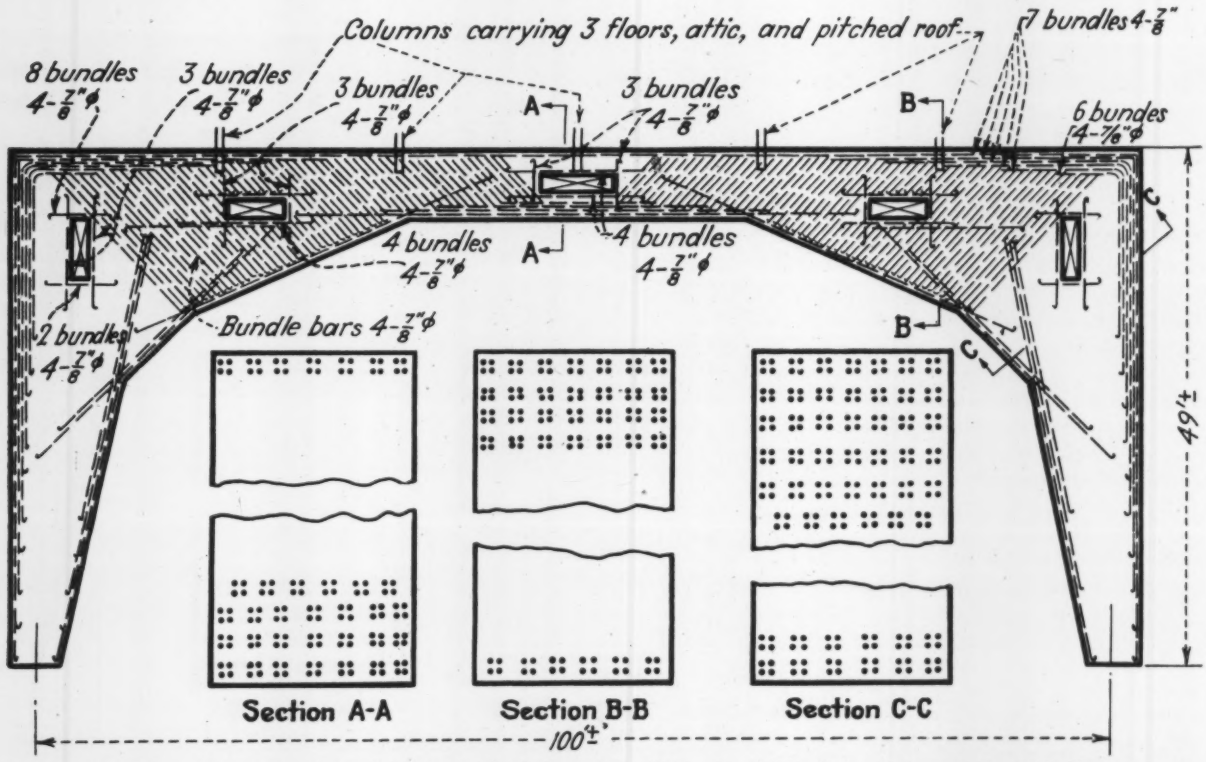


Fig. 8. Details of rigid frames Q2 and Q3 over ice skating rink. Note use of "bundle" reinforcement. Reduction of center section to accommodate air-conditioning duct appears likely to cause the frame to act very nearly as a 3-hinge bent.

Fig. 1. Heavy stone riprap replaces original precast concrete blocks installed to protect Kingsley Dam from wave-wash scour.

Kingsley Dam Gets a New Stone Facing

***Contents in Brief**—Precast concrete riprap installed in 1941 on Kingsley Dam, near Ogallala, Neb., failed to prevent unforeseen, disastrous wave-wash scour on the upstream face of the hydraulic fill. All old riprap above lake level is being removed and replaced with a 3-ft. layer of quarried stone riprap.*

AN EXPENSIVE LESSON in the protection of hydraulic fill dams against wave-wash action has been learned at Kingsley Dam on the North Platte River near Ogallala, Neb., where it has been found necessary to remove 190,000 sq. yd. of the 450,000 sq. yd. of precast concrete block riprap placed on the dam originally and to add 500,000 tons of large quarried stone, dumped and bulldozed into place. An additional 250,000 tons of fine material also is being placed beneath the new riprap to serve as a filter cushion.

Kingsley Dam, originally called Keystone Dam, forms the main storage reservoir (Lake McConaughy) for the Sutherland and Tri-County projects of the Central Nebraska Public Power and Irrigation District (*ENR*, April 27, 1939, vol. p. 546, and May 25, 1939, vol. p. 723). It is a hydraulic fill, the shell being made of river gravel, which contains a high percentage of fine material. The reservoir when full had a maximum depth of 140 ft., a capacity of 2,000,000 acre-ft., and a length of 23 miles.

Construction of the dam was begun in 1938, and the hydraulic fill was completed in 1941. Subsequently, the compacted fill forming the top of the dam, a concrete wave wall and a flexible mat of precast reinforced concrete riprap were added, that work being completed in 1941. As the operating scheme called for a large drawdown of the reservoir, the riprap was placed from El. 3293 at the wave wall to El. 3180 at the toe wall, a vertical distance of 113 ft. This riprap was precast and placed at a cost of slightly over one million dollars.

Most riprap placed in the dry

Except for a short section at this wave wall, the slope of the paved section is 1 on 3.

Some riprap installation necessarily will be subaqueous but the majority is being placed in the dry. Present construction schedules are geared to keep ahead of the rising water as summer and fall rains fill the lake.

First signs of failure occurred in the spring of 1942 when a large area of old riprap became undermined and subsided into the face of the dam. This collapse was caused by unforeseen wave action against the old riprap. Westerly winds sweeping across Lake McConaughy set up 8-ft. waves that dashed some 60 ft. up along the riprapped face of the dam. As they receded they virtually sucked the river gravel out from between and from underneath the old riprap causing it to collapse.

At the time of its installation, the old precast concrete block riprap was considered the most satisfactory material for protecting the dam from ice and wave action. It was cheaper than quarried stone, which was unobtainable in sufficient quantities within 185 miles of the dam. It provided a dam facing sufficiently flexible to permit unequal settlement without danger of rupture. Its corrugated surface was intended to prevent waves racing up too high on the freeboard. It would not be affected by shrinkage or temperature

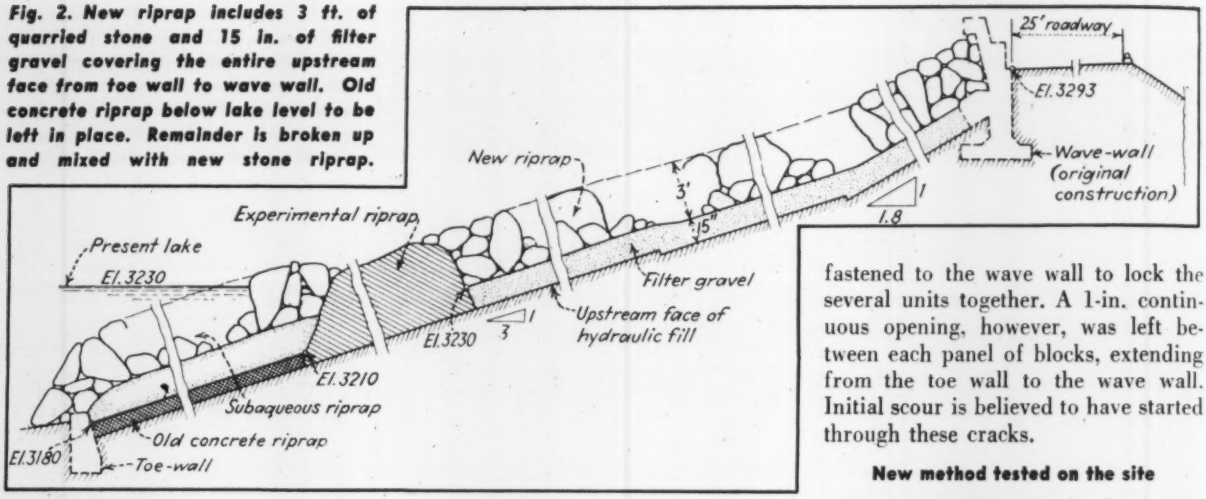


Fig. 2. New riprap includes 3 ft. of quarried stone and 15 in. of filter gravel covering the entire upstream face from toe wall to wave wall. Old concrete riprap below lake level to be left in place. Remainder is broken up and mixed with new stone riprap.

cracks as would be the case if monolithic concrete paving was used, and it provided free drainage of the face of the hydraulic fill.

Old riprap anchored in place

Three sizes of concrete blocks were used in the original dam facing; 4½ in. x 9 in. x 4½ ft., 6 in. x 15 in. x 4½ ft., and 6 x 18 in. x 4½ ft. (*ENR*, July 14, 1938, vol. p. 55). The blocks were placed with their smallest dimension paralleling the slope of fill, and their 4½-ft. length parallel to the longitudinal axis of the dam.

Two sets of steel rods, anchored to the toe-wall, were extended up the face of fill through each row of blocks, and fastened to the wave wall to lock the several units together. A 1-in. continuous opening, however, was left between each panel of blocks, extending from the toe wall to the wave wall. Initial scour is believed to have started through these cracks.

New method tested on the site

The initial failure of the old riprap had serious potentialities since similar destructive action could be expected as the lake gradually filled and the wave line progressed toward the top of the dam. In searching for a solution, a huge experiment was conducted on the site. It involved the placing, by force account, of about 200,000 tons of loose stone riprap piled 3 ft. high on a 15-in. layer of filter gravel.

An area covering the worst failure of old riprap was chosen for the experiment, which extended over a period of 1½ years. At the end of this time, the effectiveness of the method had been so well demonstrated, that a contract was let for the balance of the work, which was to be performed in a like manner.

Re-riprapping the face of dam above lake level involves three operations (1) removal of damaged sections of the old concrete riprap, (2) placing a 15-in. layer of filter gravel on the hydraulic fill dam, and (3) installing the quarried stone riprap. The old riprap that is removed is broken up and mixed with the quarried rock.

Stone riprap specifications

Specifications require that the quarried riprap, which is a hard dolomite limestone produced near Guernsey, Wyo., about 220 miles northwest of the dam site, shall have a maximum size of 6 cu. ft., weighing about 1,000 lb. At least 5 percent of the new riprap must be stones weighing more than 500 lb. each, while 50 percent of the material must be at least 100-lb. stones. These specified sizes, together with the broken pieces of old concrete riprap give sufficient gradation to produce a bulk riprap capable of becoming well

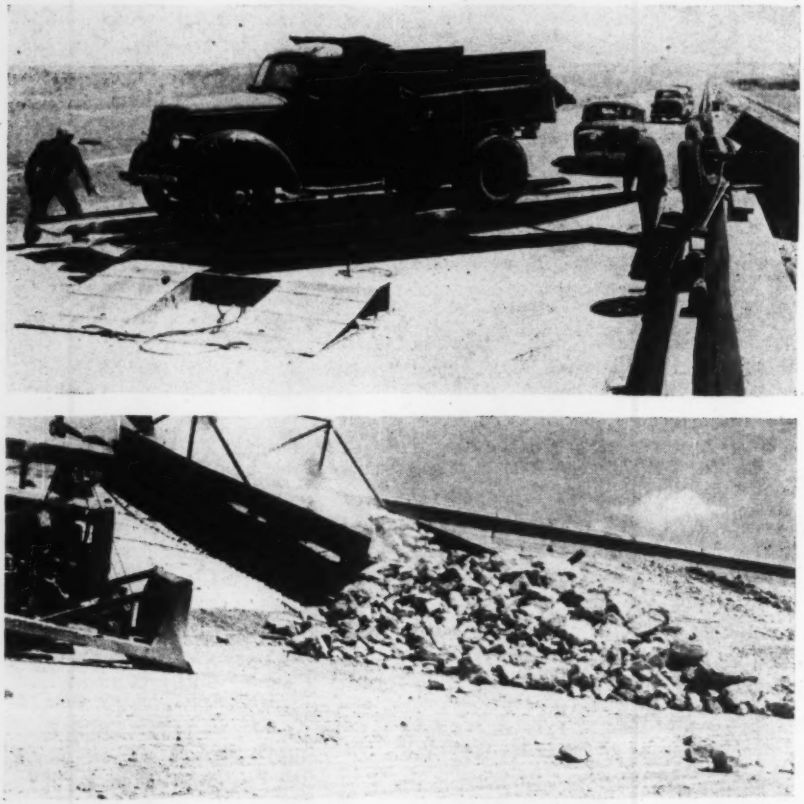


Fig. 3. Dumping the riprap and gravel onto the old concrete facing is facilitated by a job-made turntable on top of the dam (at top) and a portable metal chute operating along the wave wall (at bottom).

keyed together as it is bulldozed into place.

Gravel for the 15-in. filter layer is produced at a nearby gravel plant capable of turning out 250 tons per day. It is graded from ¼ to 2 in. with not more than 5 percent passing a No. 4 screen.

Installed with power equipment

Due to the large quantities involved, economy of construction dictates that all riprap and gravel be placed with power equipment, insofar as possible. Practically the only hand work is that of breaking up the old concrete riprap that must be removed, much of which has been done by prisoner-of-war labor. The steel locking bars prevent breaking up of the old riprap with bulldozers or power shovels.

The quarried rock is delivered at the site in bottom-dump railroad cars which are switched onto a siding near the north end of the dam. The siding was built on a 2-percent grade to permit further movement of the cars by gravity. Two traveling cranes operating on a temporary road built parallel to the spur, unload as much of the riprap into 3-ton dump trucks as can be conveniently picked up with a 3-leaf orange-peel bucket. The remainder is dumped through a concrete and timber trap located at the lower end of the spur, where it is loaded into the trucks with a ⅜-cu. yd shovel.

Both the riprap and gravel are trucked along the roadway on top of the dam and dumped over the wave wall down onto the old concrete riprap, from whence it is bulldozed into place.

Truck turntable used to advantage

Two pieces of job-made equipment were required to permit dumping over the wave wall. One is a hand-operated turntable for turning the trucks on the 25-ft. roadway along the crest of the dam. The other is a 50-ft. long traveling chute made of steel plates and angles. The latter is equipped with two steel wheels at the lower end that roll along the face of the old concrete riprap, and two rubber-tired wheels at the top that operate along a recess in the wave wall. The chute is moved by a road grader operating along the roadway in front of the wave-wall.

Chief purpose of this chute is to throw the riprap and gravel far enough down the face of the dam to be reached by bulldozers. As would be expected, bulldozing on the upstream face of the dam is rugged work. Repair and replacement of steel grousers on the tractors caused by their twisting and sliding on the corrugated face of old riprap is a continuous and expensive operation.

Fig. 4. Quarried stones not easily removed by an orange-peel bucket are dumped into a stone trap and loaded by crawler crane into dump trucks.

Fig. 5. Filter gravel is stockpiled on the old precast concrete block riprap, ready to be bulldozed into place on a cleared working area.

Old riprap is reused

As the old concrete riprap is broken up it is stockpiled just below the working area. The 15-in. layer of filter gravel then is deposited over the area, after which the broken pieces of concrete are mixed with the quarried rock. Then the final riprap is bulldozed into place to a 36-in. depth over the filter gravel.

No attempts are being made to remove the old concrete riprap lying below the level of the lake. It will be protected, however, by a 15-in. layer of gravel on which will be placed a 3-ft. layer of riprap. This subaqueous work was started Oct. 1 and is being performed by a small floating barge hauled overland to Lake McConaughy.

Re-riprapping the upstream face of Kingsley Dam began on Sept. 15, 1944, and completion date is set for September, 1946. Tobin Quarries of Kansas City, Mo., is the contractor. Ralph Saathoff is superintendent of construction, Herbert Peterson is general foreman and Ray Smith is field office manager.

The work is being performed for the Central Nebraska Public Power and Irrigation District under the direct supervision of E. J. Mecke, resident engineer, reporting to R. O. Green, assistant chief engineer and George Johnson, chief engineer. Harry S. Mahood is project engineer for the Federal Works Agency, which is financing the work, and W. C. Burke is construction engineer.

Contract cost for the entire work is $3,180,000 of which nearly $1,250,000 are freight charges for shipping the riprap from Guernsey, Wyo., to the dam site.

Dry Packing and Grouting of Substructure Salvages 90-Year-Old Montreal Bridge

***Contents in Brief**—Grouting under pressure was successfully used to replace mortar and solidify the masonry of piers built in 1854 for a bridge across the St. Lawrence River. Deteriorated stones in the exterior masonry are replaced by packing with crushed stone and intruding grout, with essential admixtures, into it. Long approach abutments of stone arch construction have been strengthened by forming a new arch underneath the original by dry packing crushed stone against the arch and forcing grout into it to make concrete.*

COMPLETE RETROGRESSION to sand of the lime mortar, in which 111,000 cu. yd. of stone masonry of the Victoria Bridge across the St. Lawrence River at Montreal was laid, has required extensive restoration to salvage the 90-year-old stone piers and arch abutments.

The Victoria Bridge was built in 1854-1859 for the Grand Trunk Railway and for many years was the only fixed crossing of the St. Lawrence River. It has always been one of the most important trade routes in Canada. About 1898 the long superstructure, originally a single track iron "tube," was replaced by pin-connected through trusses, which now carry the double-track main line of the Canadian National Railway. Also accommodated on the bridge, cantilevered outside the trusses, are an important electric railway and a two-lane highway.

The load now carried on the substructure is seven times greater than the weight put on it when the bridge was built. Heavier loading, coupled with only point support of many stones due to failure of the mortar, has caused vertical cracks extending the long way of many of the piers. This progressive deterioration of the substructure has made it increasingly imperative that the piers either be replaced or repaired.

The bridge has 24 spans of about 245 ft. and one channel span of 330 ft. It rests on 24 piers and two abutments, each founded on solid rock and was built in the dry inside floatable caissons or cribs in water 5 to 15 ft. deep at low summer flow. Since the structure has withstood very swift current and extreme winter conditions, where ice has sometimes piled up over the top of the piers, for about 90 years it must be assumed that the lime mortar and the workmanship originally were of the best quality.

The piers are 22½ x 92 ft. at the base. The upstream end of each has a pointed cutwater, which slopes 1 to 1 from below low water to above high water to break up the ice. The piers are 50 to 60 ft. high and at the top are 16 ft. wide. Originally they were 33 ft. long, but were lengthened at the top when the new superstructure was built. Piers at the channel span are 8 ft. wider than the others. Long enclosed abutments at each of the spans have a sloped face upstream and a vertical wall on the downstream side.

All of the masonry work is coursed ashlar with the top, bottom and ends of each stone of the perimeter courses dressed. The exposed faces of the stones are rough dressed and the backs irregular. Spaces inside the perimeter courses in the piers are filled with random stones.

In addition to loss of bond some of

Fig. 1. Grout forced into masonry takes the place of deteriorated mortar in piers of Victoria Bridge at Montreal, built 1854-1859. Right: Typical size of the openings where sand from original mortar has been scraped out of joints in the masonry.

the stones have not withstood the weathering and, particularly in the cutwater ends of the piers, the faces of some large units have disintegrated. Failure of the stones has accelerated in recent years, believed due largely to loss of effectiveness of the mortar and subsequent entrance of moisture followed by spalling from frost action.

Stone packing and intrusion grouting

The method adopted for repair of the piers is to pump grout containing essential admixtures into them to make cement mortar of the sand remaining from the original mortar. Where large volumes are required, such as where stones require replacement, well graded crushed stone is packed into the area which is then filled with the special grout to make concrete. Both of these processes are patented.

In repairing the piers, holes are drilled horizontally into them at almost every point of intersection of a vertical joint with the horizontal course beneath it, making a pattern of holes at about 3 x 8-ft. centers. From just above the water line, holes are drilled into the piers at an angle of 15 deg. and 60 deg. with the vertical to reach all parts of the base. Some of the holes extend into the bed of the river to permit foundation grouting and thus assure full bearing of the base course stones.

Holes to be drilled through several feet of stone are started as large as 3-in. dia. to allow for reduction in size for successive steel changes to a minimum of $1\frac{3}{4}$-in. dia. at the bottom. The exposed joints in the masonry are cleaned out and the interior of the pier washed out so far as practical with high pressure water jets directed into the drilled holes. After no more sand can be washed out, the joints are pointed to a depth of at least 8 in. with cement mortar to seal all openings except, of course, the drilled holes.

Two stage grouting

Grouting is done in two stages, first with cement mortar at low pressure to fill any existing openings, and later with a neat cement grout at high pressure to assure filling any remaining voids in the sand. A $1\frac{1}{2}$-in. dia. pipe, long enough to extend to the full depth, is inserted in successive drilled holes, starting at the bottom, and all of the mortar forced in that the hole will "take." A "packer" around the pipes, arranged so that it can be expanded to

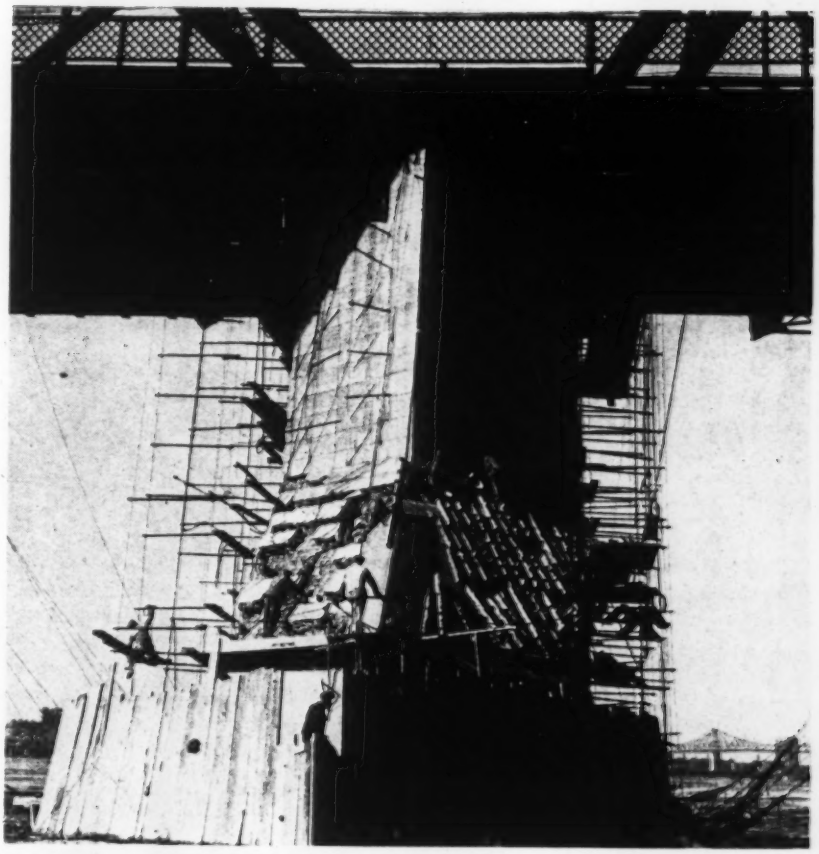


Fig. 2. Broken stones are replaced by cutting back to good material, forming and then dry packing with stone into which grout is forced to make concrete. Note rope net and timber shield to protect masons and divers from the swift current.

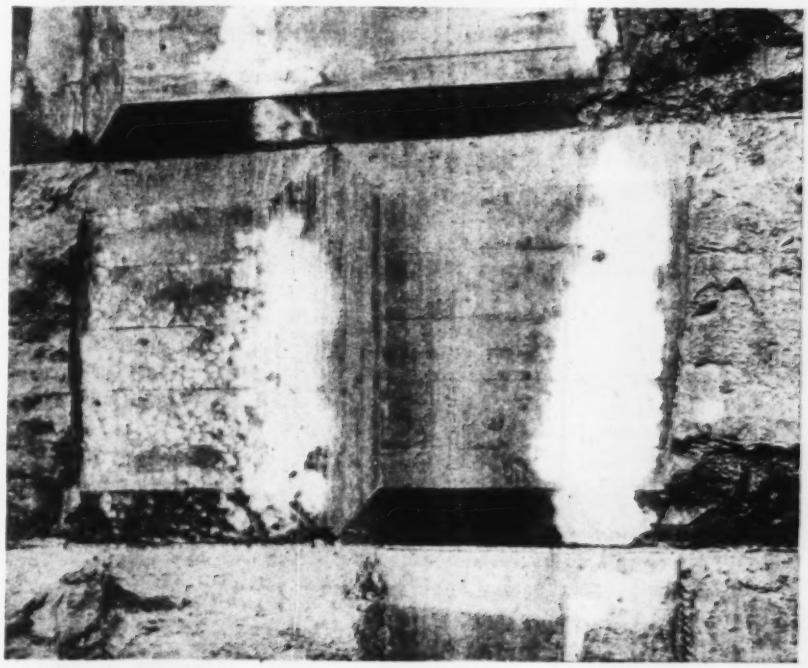


Fig. 3. After weathering, replacement "stones" blend unobtrusively into the structure.

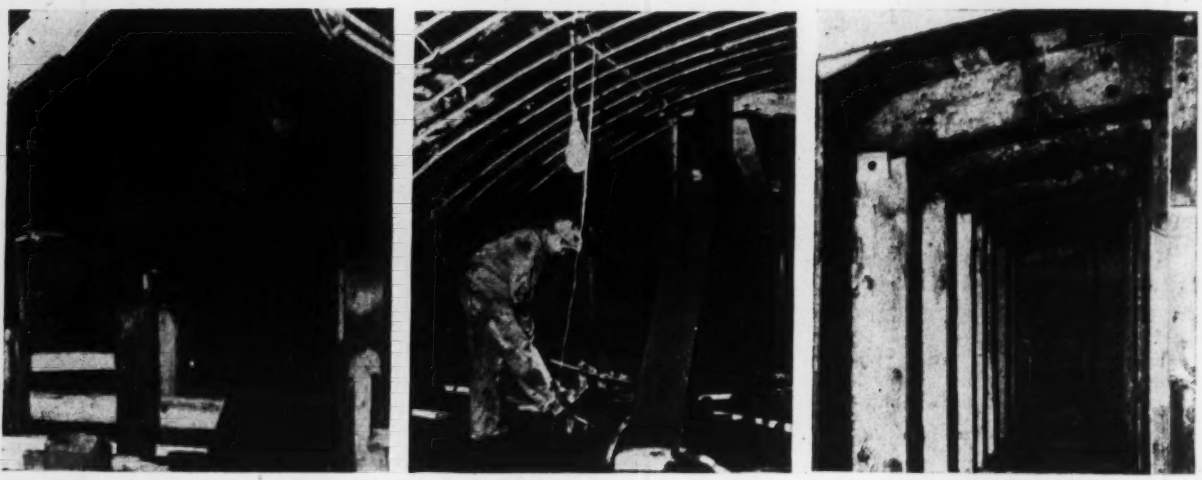


Fig. 4. New construction inside existing abutment arch renews the structure. Left, corbelled arch after sandblasting; center, reinforcing hung from roof; right, forms in place for dry packing and grouting to make a concrete arch.

entirely close the hole, prevents grout from coming out along the pipe. Divers examine the underwater portion of the piers and take necessary steps to stop any flow of grout from underwater. In the very swift water of the St. Lawrence River, a shield around the upstream end of the pier is necessary to protect the divers from being swept down stream.

Large volumes filled

For grouting, a mixture of three bags of portland cement and one bag of an admixture intended to reduce shrinkage and delay hardening of the mix are used. In the first stage intrusion, 4 to 5 cu. ft. of sand are added to this mixture. An air driven, two-cylinder reciprocating pump is used to force the rather fluid mortar into the piers. A large amount of grout ordinarily is taken by the piers on the first grouting, one pier having required 9,000 bags of cement. The intrusion pipe is placed to discharge at the lowest point of the pier and no attempt is made in this operation to build up pressure other than that required to force the mortar up so that it is extruded from successively higher levels in the pier. Holes above are kept open to vent the air and to show the progress of the filling.

After this grout has had an opportunity to harden, all of the holes are redrilled and a neat grout of three parts of portland cement to one part of the admixture is forced in. Pressures up to 350 psi. are used at the foundation rock level, but this is reduced to relatively small amounts near the top to prevent cracking the capstones of the piers. Comparatively small quantities of cement are used in the regrouting.

Displaced stones are replaced and broken stones repaired by filling the areas with crushed stone, well graded to secure a minimum of voids, then forcing in grout under pressure to coat the stones and form the mass into concrete. Broken stones are chipped out to a depth of a few inches, a wood form is built against the pier to the shape of the stone to be replaced and the space inside packed tightly with stone. Forms are held in place by expansion anchors and are caulked all around so that a pressure head can be applied to force in the grout. Calking is accomplished with soft rope, tacked to the form in such a position that it leaves a mark similar to the pointing between the stones.

Repairing the abutments

The abutments of the bridge presented an entirely different problem from that of the piers. Details of their design were not known to the repair crews, but they appeared to be solid masonry with an interior rubble fill that was settling, presumably due to deterioration of the lime mortar. Prescribed treatment was to intrude grout to fill the joints between the stones. When drills into the interior, from the downstream face of the south abutment, struck large voids, however, an opening was cut through the perimeter stones disclosing stone arch construction under the bridge roadway and a deteriorated condition even worse than in the piers.

The interior stone was thoroughly cleaned by sandblasting and what amounts to a new arch was built inside the existing one to reinforce and preserve the original. All of the concrete placed to reinforce the arches was made by forming to the desired shape and then packing with carefully selected crushed stone, followed by filling with mortar grout under pressure.

Concrete arch reinforces masonry

A new wall was built against the arch piers up to the springline, 25 ft. above the base, and in one instance four pilasters were used, surmounted by a concrete beam at the springline. Above the springline and directly against the old stone, a new arch barrel 12 in. thick was placed. Under the corbelled arches upstream a similar shell of concrete was placed to reinforce the structure and serve the additional function of an enclosing wall against which grout could be intruded under pressure to reestablish the strength of the entire masonry wall.

Repair of the Victoria Bridge has been under way for some time and now is nearing completion. Chas. P. Disney, engineer of bridges, Canadian National Railway, Toronto, is in charge of the work, with Mr. Redmon, assistant engineer, Toronto, supervising the work in the field.

The methods described in repairing the bridge originated and are patented in the United States and Canada by the Intrusion-Prepakt Co. of Toronto and Cleveland, which is doing the reconstruction work. Wm. Johnson is superintendent for the contractors, and H. Henrich is in immediate charge of the field work.

HIGHWAY PLANS for 1946

THE YEAR now opening will see the inauguration of the greatest highway building program ever authorized. Federal aid in the amount of a half billion dollars for each of three years has been authorized by Congress, the states have a great backlog of available funds, and an unprecedented amount of planning has been advanced to the contract stage. Thus, a high goal has been set.

PROGRESS made to date in attaining that goal is recorded in the opening pages of this special section. There follows a discussion of one of the factors that will have a major bearing on progress toward the goal — highway cost trends and uncertainties.

DESIGN STANDARDS that have been set for the National System of Interstate Highways, which is to be started as part of the current roadbuilding program, also are included in this section, and the section contains a continuation of the discussion begun last year of the truck weight and size limits, special reference being made to the limits proposed for the interstate system.

Highway Construction Outlook—1946

***Contents in Brief**—Work planned by the state highway departments indicates that about $800,000,000 worth of road construction will be put under contract this year if conditions are favorable. New grading may reach 15,000 miles and new paving of all types will probably exceed 18,000 miles. Engineering manpower, particularly in survey parties and for supervision of construction, threatens to be one of the chief bottlenecks. Contractors are available in sufficient number except in a few localities, and the supply of all materials except lumber appears to be adequate.*

EXPENDITURES approaching $800,000,000 on federal and state-aid highways are in prospect for 1946. About 15,000 miles of new grading and draining is contemplated and the amount of pavements of all types proposed to be laid during the year will exceed 18,000 miles if current plans of the state highway departments, as reported to this journal, can be carried out.

When the proposed expenditures on town and county roads and on city streets not included in the federal-aid system are added to the expenditures planned by the state highway departments, it becomes apparent that the potential highway-building program for 1946 may be greater than any prewar year except possibly the early Thirties when highway expenditures throughout the nation were stepped up enormously to provide employment.

Some unfavorable factors

But the speed with which road-building is implemented and the success of its prosecution still depends on several nebulous factors. Reports from 44 of the state highway departments indicate that in several states shortages in engineering personnel may be a serious deterrent in getting the highway program underway, despite the increasing number of engineers returning from the armed services during the past few weeks.

Some construction materials will be in short supply, but the situation should not be serious. Lumber is reported scarce in most regions, but the supply is improving at some points.

Checks made by Associated General Contractors of America indicate that contractors are available to undertake the proposed program, but the answer to this question will not be forthcoming until early spring when work gets underway.

On work so far put out for contracts, most state highway departments have received a sufficient number of bids. A few, however, have received only one bid on some jobs. These, generally, have been small jobs involving some peculiar working conditions.

High bids received

Another factor that will have a very direct relation to the rate at which plans are converted into contracts is the spread between engineers' estimates and contractors' bids. This subject is considered in more detail in the discussion of cost trends beginning on page 128. Bids on some work have been rejected as being too far out of line with the estimates, but bidding conditions generally are not as serious as they appeared to be early in the winter.

The situation is summed up by C. Coykendall, administrative engineer of the Iowa commission, who says: "Our commission recognizes that the dollar is definitely cheaper than it was in the prewar period, and that we must expect to pay higher prices for our highway construction work. So long as the higher level of prices seems to be in keeping with the current value of the dollar, we will expect to continue to award contracts for 1946 construction work."

Availability of labor

The amount of construction labor that will be available for highway work is an additional factor that will have an important bearing on the rate at which the new work gets under way. Most highway departments report labor to be scarce and a few characterized it as very scarce. Harry Coons, chief engineer of the Michigan department sums the situation up in saying: "Construction labor *that wants to work* is scarce".

Harry Henderlite, chief engineer of the Louisiana Highway Department states that labor in his part of the country is indifferent rather than scarce. About 12,000 persons in Louisiana are receiving unemployment compensation simply because they are unwilling to return to the type of work they were doing before the war.

It now appears certain that construction labor will continue to be scarce for an indefinite period. Men on whom the construction industry counted for common labor and for part of its skilled and semi-skilled workmen went into war industries and obtained a much higher take-home pay than they had been accustomed to get. So long as industrial production continues high, these men probably will stay in industrial plants.

This condition is bound to create a shortage of available construction labor that is sure to be reflected in wages paid to construction labor despite efforts of the War Labor Board to prevent payments above the approved rates.

Losses not made up

Losses from the nation's construction forces due to natural causes—death and old age—over the past five years have not been offset, and there has been almost no apprentice training since the war construction boom of 1941-42.

Offsetting this in part will be the men released from construction units of the Army and from the Navy Seabees. These units have many thousands of trained men. However, release of these men is likely to be slow because their ability to do things that still need to be done makes the military services unwilling to release them.

Still another factor that needs to be taken into consideration is the increased number of construction men that will be needed if we are to have an annual construction budget of 12 to 15 billion dollars, which is held to

be essential to a prosperous postwar economy. That means increasing our construction force to almost twice what it was before the war.

Large expenditures planned

Some idea of what is expected of the highway construction industry this year is shown in the amount of work planned to be placed under contract this year, as shown in Table I. In answer to a questionnaire recently submitted to all 48 state highway departments, 44 report an estimated total of $781,500,000 worth of construction to be placed under contract during 1946. Of this amount, $88,600,000 will be spent for bridges and other highway structures over 20-ft. span.

By comparison it is interesting to note that, despite the fact that restrictions on construction materials were not removed until after V-J Day, these 44 state highway departments built $23,100,000 worth of bridges in 1945, and awarded contracts for $158,100,000 of other highway work.

Proposed mileages of pavement

A more detailed analysis of the amount of highway construction expected to be placed under contract this year is shown in Table II, which covers both the primary and secondary state highway system. A surprisingly large amount of two-lane portland-cement concrete pavement is expected to be built; 1,220 miles on the primary systems and over 100 miles on the secondary systems. In addition, some 270 miles of superhighways carrying four or more lanes of concrete pavement are included in the 1946 construction program.

Bituminous concrete pavement will be an important item, with over 850 miles expected to be placed under contract this year. If the several highway programs are pursued as planned, over 4,400 miles of road will be surfaced with oiled gravel while some 11,600 miles of highways will receive other types of surface treatment.

Shortage of engineers

Only 13 of the state highway departments hold any degree of optimism regarding the return of sufficient engineering personnel in time to handle the volume of work planned for the 1946 construction season. Most of the others report the situation as varying all the way from "extremely acute" up to "50 percent adequate." Some even contemplate augmenting their field crews at the expense of further depleting their office staffs.

New York, which contemplates a total highway construction of $850,000,000 over the next five years has taken steps to expand its highway field and office staffs by 200 percent. Utah has a fairly adequate office staff but could use some more bridge designers. When construction gets under way this spring, however, the highway department will need four times its present number of construction engineers and twice as many survey crews and right-of-way engineers as are now employed.

Virginia is among those experiencing extreme difficulty in securing the services of qualified engineering personnel for the completion of field surveys and the preparation of construction plans. Several additional survey

TABLE I. HIGHWAY CONSTRUCTION CONTRACTS AND FUNDS AVAILABLE

State	Contracts awarded (1945) [Thousands of dollars]		Estimated contract construction (1946) [Thousands of dollars]				Funds available for 1946 construction [Thousands of dollars]	
			Jan. 1 to July 1		July 1 to Dec. 31		Federal aid	State
	Structures	Total	Structures	Total	Structures	Total	(See Note)	(matching)
Ala.	———	5,700	1,200	7,200	800	6,033	19,495	14,000
Ariz.	100	1,100	500	7,000	400	6,000	5,728	2,900
Ark.	370	791	———	3,000	———	4,500	11,000	4,000
Calif.	5,000	23,000	5,000	24,000	7,000	31,000	33,000	33,000
Colo	———	———	———	6,000	———	6,000	5,000	5,000a
Conn.	1,200	4,000	1,800	8,000	1,500	12,000	6,500	6,500
Del.	———	656	75	1,100	600	1,310	4,223	1,073
Fla.	———	———	———	———	———	———	———	———
Ga.	451	6,883	3,000	10,000	3,000	10,000	16,000	16,000
Idaho	143	———	———	9,660	———	———	10,980	5,000
Ill.	1,285	12,919	———	———	———	———	25,740	b
Ind.	345	1,506	2,800	15,000	1,800	9,300	15,600	12,100
Iowa	———	———	———	———	———	———	———	———
Kans.	388	3,763	———	15,000	———	10,000	26,333	26,333
Ky.	281	5,235	2,122	15,196	600	5,000	17,815	11,800
La.	———	———	———	———	———	———	———	———
Me.	200	250	1,500	7,000	1,000	3,000	4,550	4,550
Md.	770	3,267	650	4,168	907	1,895	4,792	4,792
Mass.	———	2,200	———	9,800	———	10,000	14,700	14,700a
Mich.	67	210	3,500	16,000	3,500	16,000	14,000	18,000
Minn.	46	595	1,800	15,000	1,200	9,000	27,600	20,000
Miss.	10	95	500	5,500	1,000	11,250	11,000	11,000a
Mo.	629	2,887	———	14,427	———	20,851	17,828	16,740
Mont.	232	1,998	1,200	7,700	1,400	8,800	10,135	6,385
Neb.	655	1,620	2,040	13,600	210	1,400	9,800	7,200
Nev.	100	1,015	130	3,330	40	1,225	5,000	1,050
N. H.	314	809	1,204	3,198	———	730	2,908	1,618
N. J.	1,002	2,876	———	———	———	———	9,433	9,433a
N. M.	450	2,140	750	8,500	500	5,000	12,823	6,600
N. Y.	———	14,836	———	50,000	———	75,000	67,784	b
N. C.	1,049	6,651	2,500	7,000	3,000	8,500	13,208	12,088
N. D.	565	1,914	250	2,500	125	2,000	5,974	3,000
Ohio	500	10,200	2,500	12,000	3,500	17,000	21,000	26,400
Okla.	2,655	10,675	400	5,000	2,000	10,000	10,142	23,500
Ore.	1,400	7,200	2,250	11,000	1,500	9,000	7,100	5,000
Pa.	———	10,000	———	———	———	———	24,973	24,973
R. I.	———	415	———	———	———	2,000	4,000	b
S. C.	995	3,155	4,500	13,400	2,000	6,000	13,600	13,600
S. D.	94	200	500	1,000	500	3,000	5,600	4,000
Tenn.	———	———	———	———	———	———	———	———
Tex.	———	14,000	———	30,000	———	30,000	40,000	40,000
Utah	———	———	———	———	———	———	4,651	1,993
Vt.	50	380	190	1,900	140	1,600	2,040	2,052
Va.	300	4,000	1,000	7,000	1,500	10,000	8,797	8,596
Wash.	1,097	5,800	1,298	8,045	1,500	6,000	8,788	8,885
W. Va.	199	3,319	1,058	5,700	520	5,500	5,600	5,600
Wis.	———	800	———	5,000	———	10,000	17,000	17,000
Wyo.	165	2,185	625	3,860	———	2,860	4,825	2,600
Total	23,107	181,245	46,842	392,754	41,742	388,754	607,065	459,061

a Estimated; depends on state legislative action.
b Not available.
Note: Available federal funds cover 1, 1½ or 2 postwar fiscal years.

parties, however, have been organized by the highway department recently, while the number of former employees gradually returning from the armed services during the past few weeks indicates that vacancies in the department's depleted engineering ranks may be filled early this year.

The North Carolina highway department visualizes the greatest scarcity of engineers to carry on highway construction that has ever existed in that state and it predicts the keenest of competition between the various agencies for qualified engineers. An estimated 500 percent increase in existing field and office personnel will be required to handle the state and federal-aid construction programs contemplated for this year in North Carolina.

Use few consulting engineers

In general, consulting engineers are not being employed extensively to prepare highway design plans, although there is a rising trend toward their use for this work. Seven state highway departments employ consulting engineers, three expect to do so in the near future, and 18 states report no need for them whatsoever.

Maryland employs consulting engineers to design highway structures of unusual design and magnitude as well as for preliminary studies of some of the more complicated projects. Notable among these are a proposed bridge across the Baltimore Harbor, the widening of the existing bridge over the Severn River between Baltimore and Annapolis, and the proposed Baltimore-Washington freeway.

Surveys and plans for a large urban project in Birmingham are being prepared for the Alabama highway department by a private engineering firm.

Ohio has two projects on which surveys and plans are being prepared by consulting engineers, while Missouri, Virginia and West Virginia contract with such organizations for some of their bridge designs. None of the states report the use of consulting engineers for supervision of highway or bridge construction.

Consulting engineers are used considerably by the Pennsylvania state highway department to prepare field surveys and design plans, but not to supervise construction. The work is done by contract with experienced concerns and is generally divided in two phases (1) the making of preliminary plans and field surveys, and (2) preparing final designs and construction plans.

Massachusetts contemplates using consulting engineers to prepare plans for some of the 385 additional highway bridges which were placed under the department's jurisdiction, Jan. 1, 1946, in accordance with a 1945 act of the state legislature. Michigan contemplates the limited employment of consulting engineers to make highway surveys and to prepare design plans for construction, while Oklahoma has entered into a few contracts with such organizations for the same purpose.

Consultants on county work

Indications point toward an increase in the employment of consulting engineers to make surveys and prepare plans for counties, in connection with federal aid secondary construction. Several such organizations are engaged in this field in Kansas which contemplates a $6,400,000 county secondary highway construction program for each of the next three years. A few Minnesota counties also employ consulting engineers, mostly for the preparation of bridge plans.

The North Carolina state highway department employs no consulting engineers since it believes that such practice would be a deterrent to the building up of the department's own engineering force, chiefly because such organizations often are in a position to pay greater salaries than can be paid by the state.

No difficulty is envisioned by the Minnesota state highway department in the completion of sufficient plans or acquisition of right-of-way for this year's program except possibly some urban projects where the inadequacy of housing facilities may increase the difficulty of securing right-of-way.

California is faced with conditions similar to those in Minnesota regarding the initiation of some of its construction projects in urban areas. It may be necessary to delay starting several large projects passing through thickly populated sections in metropolitan areas due to extremely critical housing shortages.

Availability of contractors

As mentioned previously, most highway departments report that on the work let to contract in 1945 they have received a sufficient number of bids, except on a few small jobs involving special conditions. In some of the North Central States—notably Minnesota, North and South Dakota and Nebraska—there appears to be a definite shortage of contractors to bid on highway work.

In Minnesota, bids on the small amount of work placed under contract last year indicate a possibility that the volume of work actually placed under contract this year may be materially less than that which can be financed with available federal, state and county funds.

Michigan has decided not to advertise any highway construction for the present due chiefly to unsettled labor conditions, while the Wisconsin state highway department has confined its recent lettings to bridge construction in the belief that more uniform bids will be received on the larger projects if they are not advertised until just before the construction season starts.

What some states are planning

Immediately upon release of construction activities by the War Production Board last year, the Maryland state highway commission resumed advertising of construction projects. Bids were received on several such projects during the latter part of 1945, the most outstanding of which is the superstructure for the Sandy Hook bridge over the Potomac River between Washington Co., Md., and London Co., Va. A contract for this work was awarded Dec. 19 to the Bethlehem Steel Co. on their low bid of $767,660.

Considerable activity also is being centered on secondary and feeder roads in Maryland. Several field surveys are being made by the state highway commission, plans are being prepared and construction of several projects is expected to be started early this summer.

Project plans and estimates aggregating $2,800,000 worth of highway construction in Utah are now in process of approval by the Public Roads Administration. As soon as the projects are approved they will be advertised by the state highway department. West Virginia is giving considerable attention to adding a maximum number of all-weather roads to the state's system of highways. To do this, the state highway department contemplates the construction of several miles of low-type surface roads as a part of its federal-aid secondary system to serve rural homes, churches, schools and markets.

As a definite step toward the solution of congested highway routes within large cities in Indiana, the state highway commission has been conducting traffic surveys in three of its major cities. All basic field work on the three surveys was completed last Dec. 7 and reports covering all phases of the surveys with final recommendation of expressway routes, attendant descriptions, maps and estimated costs are now in preparation. The first report should be finished by March 1, and the other two before the end of this year. About $70,000 has been expended on this work, to date, with the state and the federal government sharing equally in the costs.

Extension of the Wilbur Cross Parkway is perhaps the outstanding resumption of activity by the Connecticut state highway department. This highway, on which construction was started before the war, extends from the eastern terminus of the Merritt Parkway across the state in a northeasterly direction to the Massachusetts border.

Contracts are now being let for some grade separation and major drainage structures, and some paving contracts will be let soon on that portion of the parkway between Meriden and New Haven. Bids also are expected to be taken some time this year on the Wilbur Cross Highway extension north and east of Hartford.

More secondary road work

The one item of greatest importance in South Dakota from the standpoint of proposed highway construction is the development of its federal-aid secondary program. This was of a very minor nature before the war. Now, however, available federal and state funds make the extent of the program of such magnitude as to warrant its becoming one of South Dakota's major highway plans. The several counties throughout the state have enacted the necessary legislation to provide funds to carry on this secondary highway program, but it may be delayed somewhat due to the lack of engineering personnel.

As an aid in gearing public opinion to the necessity for, and the advantages of, the impending construction program, the Missouri state highway department has been holding a series of meetings throughout its ten divisions. Eight such meetings have been held to date, with gratifying results.

Texas, whose 1946 highway construction program is estimated to reach $60,000,000, has submitted its 1946 and 1947 programs for primary federal-aid, urban and secondary highways to the Public Roads Administration. Approval has been received on the 1946 primary federal-aid program and on parts of the secondary program. The highway department plans to receive bids for a number of these projects during the month of January and others in the immediate future.

TABLE II. ESTIMATED MILEAGE TO BE PLACED UNDER CONTRACT IN 1946 CLASSIFIED BY TYPES OF PAVEMENT

States	Primary system (miles)						Secondary system (miles)				
	Grading and draining	Portland cement concrete: 2-Lane	Portland cement concrete: 4 or more lanes	Bituminous concrete	Oiled gravel	Other surface treatment	Grading and draining	Portland cement concrete	Bituminous concrete	Oiled gravel	Other surface treatment
Ala.	*225	27	5	—	—	156a	130	—	—	—	90a
Ariz.	—	140	—	—	50	—	—	—	—	160	—
Ark.	7	13	—	—	—	120a	38	—	—	—	148b
Calif.	320	50	100	100	20	50a	150	—	100	50	—
Colo.	—	—	—	—	—	—	—	—	—	—	—
Conn.	15	11	11	—	3	10	—	—	—	170	5
Del.	1	4	—	35	—	—	1	—	—	—	—
Fla.	—	—	—	—	—	—	—	—	—	—	—
Ga.	309	—	—	—	—	—	364	—	—	—	—
Idaho	—	6	4	160	—	—	—	—	—	210	305c
Ill.	—	—	—	—	—	—	—	—	—	—	—
Ind.	8	74	80	15	—	—	5	15	—	95	8
Iowa	—	—	—	—	—	—	—	—	—	—	—
Kan.	400	76	15	62	—	910d	1,200	3	1	—	1,779e
Ky.	125	25	3	25	—	—	156	1	—	270	92
La.	—	—	—	—	—	—	—	—	—	—	—
Me.	35	4	—	8	—	38	—	—	—	129	9
Md.	—	35	10	—	—	—	—	—	—	6	41
Mass.	—	13	6	7	—	48a	—	—	2	—	7
Mich.	300	100	—	—	—	—	—	50	100	—	600f
Minn.	372	120	6	48	54	96a	283	—	—	80	72a
Miss.	—	—	—	—	—	—	—	—	—	—	—
Mo.	156	132	8	41	619	—	1,070	1	—	6	1,080c
Mont.	230	—	—	—	230	—	400	—	—	50	400c
Neb.	324	83	1	—	311	—	286	3	—	142	—
Nev.	62	—	—	—	—	62a	175	—	—	100	—
N. H.	27	—	—	—	14	14	15	—	—	—	15
N. J.	—	—	—	—	—	—	—	—	—	—	—
N. M	30	—	—	—	170	—	150	—	—	100	—
N. Y.	—	—	—	—	—	—	—	—	—	—	—
N. C.	110	110	—	26	—	188c	12	3	40	—	222c
N. D.	127	16	—	—	111	—	—	—	—	—	—
Ohio	—	—	—	—	—	—	—	—	—	—	—
Okla.	73	32	5	13	—	25c	300	—	—	50	250c
Ore.	150	20	3	10	80	40a	300	6	—	250	—
Pa.	—	—	—	—	—	—	—	—	—	—	—
R. I.	5	5	5	2	—	—	—	—	—	—	—
S. C.	260	—	—	—	—	250h	550	—	—	—	660h
S. D.	200	—	—	—	150	—	50	—	—	—	—
Tenn.	—	—	—	—	—	—	—	—	—	—	—
Tex.	1,276	—	—	—	—	1,012i	2,448	—	—	—	2,684i
Utah	—	—	—	—	—	—	—	—	—	—	—
Vt.	* 19	3	—	—	—	16	35	—	—	13	22
Va.	240	—	—	—	—	—	—	—	—	—	—
Wash.	156	25	—	9	147	—	172	—	7	270	—
W. Va.	43	19	5	8	—	13	25	6	25	—	85
Wis.	100	75	—	25	100	—	30	20	—	100	—
Wyo.	152	—	—	—	38	—	150	—	—	75	—
Total	5,857	1,218	267	594	2,097	3,048	8,495	108	275	2,326	8,574

a Bituminous surfacing. *b* Bituminous and gravel surfacing. *c* Crushed rock or gravel. *d* Includes 596 mi. of bit. mat, 170 mi. of gravel or crushed stone, and 144 mi. of bit. penetration and seal. *e* Includes 1,600 mi. of gravel or crushed stone, 115 mi. of bit. penetration and seal, and 64 mi. of bit. mat. *f* Includes 200 mi. of plant mix bituminous surfacing, 200 mi. of surface treatment (double seal), and 200 mi. of gravel. *g* Soil type base with bit. surfacing, and traffic bound macadam. *h* Inverted penetration with seal (low type). *i* Includes all types of surfacing.

Highway Costs Show Slow Upward Trend

***Contents in Brief**—Uncertainties as to the trend of labor and material costs have resulted in wide divergence between engineers' estimates and contractors' bids on many recent highway jobs in various parts of the country. • Estimates have been increased 15 to 50 percent above prewar costs. Cost indexes indicase a general rise in construction costs of around 0 percent over 1940 prices. No sharp further rises are evident, but a slow rise appears probable.*

HIGHWAY COSTS are trending upward, but the rate and extent of the upward rise cannot be accurately gaged at this time due to the uncertainties affecting all elements of such costs.

Labor rates are unstable and the supply of construction labor in most parts of the country is scarce. Some materials going into highway construction also are scarce, notably lumber for concrete forms, timber and structural steel. Deliveries of these materials are slow and unpredictable, and no one knows when this condition will change.

Many people believe that construction materials will continue to be scarce until OPA price controls are lifted; but where prices will go then is anyone's guess due to the pent-up demand. What effect the recently reinstated priorities system will have on the supply of materials for highway work is yet to be determined.

These are the chief unknown factors affecting highway costs. There also are some known factors that may be of help in determining what highway costs are to be this year.

The most certain fact is that construction costs in general at the end of 1945 were up about 30 percent above 1940 figures. That they will not decline from that level also appears obvious.

Construction labor will continue to be scarce, for the reasons set forth in the preceding article. This is going to make it difficult to get highway work started quickly and in large quantities in the spring.

High bids on new work

Bids on some of the first construction jobs to be offered after the ban on new construction was lifted were so high that many were rejected. Highway work was no exception. For a time it looked as though bids might be so high as to result in the indefinite postponement of much road work.

New York's experience was the most spectacular. Out of $31,200,000 of new work offered, bids on $18,450,000 of the work were above the engineers' estimates and had to be rejected under state law. The engineers had increased their estimate 15 percent over 1940-41 prices, at which time contractors' bids generally averaged 20 percent below the estimates.

As a result of reports of bid rejections from other parts of the country, Engineering News-Record undertook to determine how widespread the condition was, and, if possible, to get some measure of how much the bidding was over prewar prices. To date, 36 highway departments have answered our inquiry. The net impression is more favorable than appeared probable when the inquiry was inaugurated.

In the first place, it should be said that the amount of work on which bids have been asked is relatively small, except in a few states, hence it would be unjustifiable to draw any very profound conclusions from the replies. However, some very definite trends are evident, which should be of value in looking into the future.

Contractors' bids

Generally, contractors' bids have not run much more than 10 to 15 percent over the engineers' estimates, and in a few states the bids have been *below* the estimates. The most extreme cases of

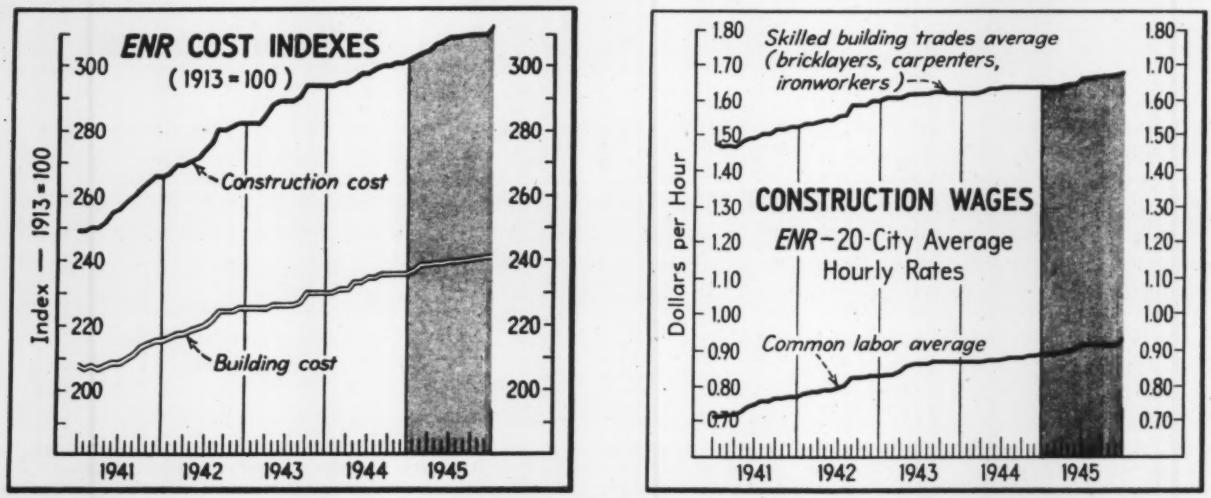


Fig. 1. The Engineering News-Record cost index (left) has not been rising as rapidly during the last two years as it did in the earlier war years. Construction wages (right) in 1945 showed a tendency to increase their rate of rise slightly.

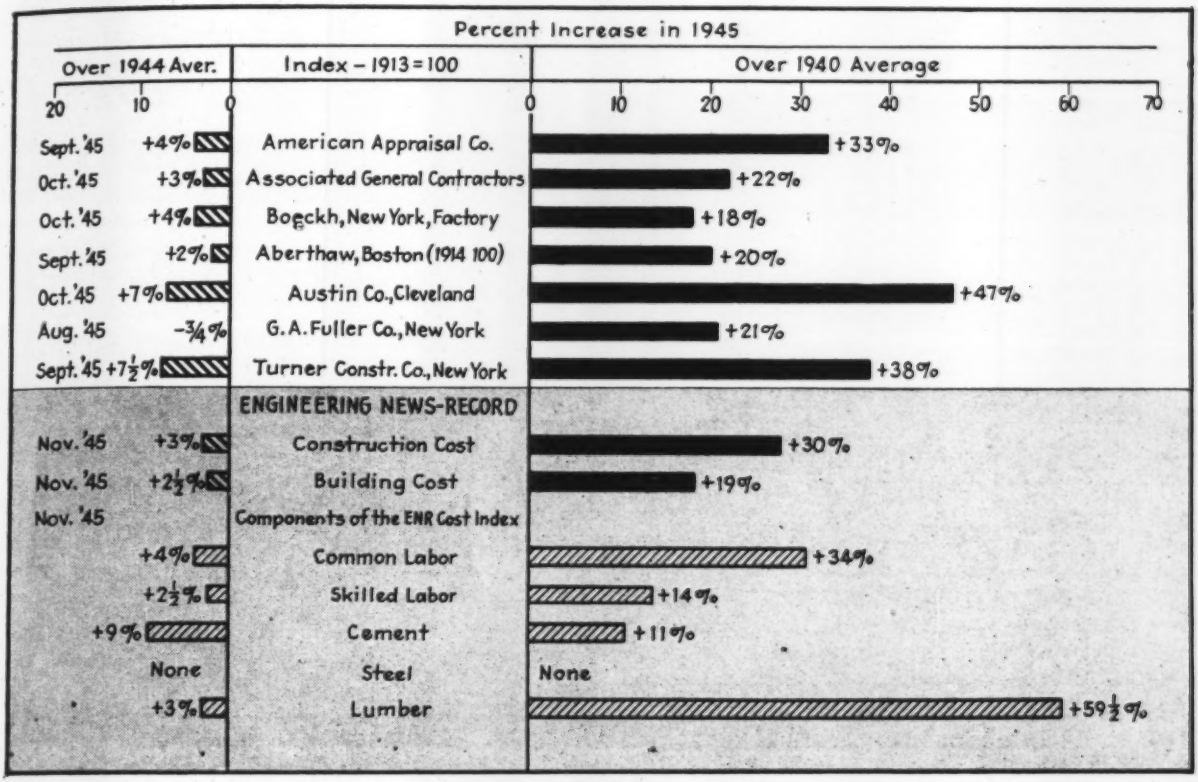


Fig. 2. Increases in current construction costs as compared with prewar costs as measured by cost indexes. The lower part of the diagram shows the component parts of the Engineering News-Record index of construction costs.

high bids come from Louisiana and Maryland. In Louisiana, bids were called on a 1,200,000 cu.yd. hydraulic fill for a highway at Lake Charles. Prewar costs for such dredging had been around 21 cents; the engineers estimated at 30 cents, and they got two bids at 40 cents, or nearly 100 percent over the prewar costs, which bids were rejected. Maryland got bids on a $90,000 bridge job that were 120 percent over the estimates.

Erratic bidding was reported by several states. On a recent letting totaling nearly a million dollars, Missouri got bids varying from 16 to 96 percent above the engineers estimates. The average was around 26 percent on estimates that had been increased 25 percent over 1941 prices.

In California, where a considerable amount of work has been put under way, bids on 28 jobs ranging from $2,000 to $700,000 averaged 6 percent *under* the estimates, but on 5 small projects the bids *overran* the engineers' estimates by 46 percent and were rejected. Two other projects got bids nearly 9 percent *below* the estimates. In appraising these bids in California, however, especially the ones below the engineers' estimates, it should be noted that the average increase in the estimates over prewar costs was nearly 40 percent.

By statute, the California Highway Department must determine the prevailing wage rate in each locality and publish the minimum wage rates in each contract. This information is published immediately prior to advertising each project, which has been found to be a material help in keeping bids in line with the estimates.

Oklahoma got bids 4 percent *below* the engineers' estimates on a $2,000,000 job. There, various items going into the estimates had been increased from 25 to 40 percent above prewar prices.

At a bid opening in October, Oregon got bids slightly under the engineers' estimates on four fairly large jobs and bids somewhat over the estimates on two others. The estimates were increased about 50 percent above prewar.

At a letting held Dec. 13-14 involving eleven highway projects with an estimated cost of $2,620,000 there was a wider variation in bids. For six projects, bids were within the estimates. Bids on the five other projects were from 12 to 44 percent above the estimates and were rejected.

In Wyoming, bids received Nov. 29 on some $8,600,000 worth of highway construction in six projects averaged 5 percent less than the engineers' estimates.

Bids on two of eleven projects in Montana totaling about $1,500,000 were rejected as too high, but the remainder were close to the engineers' estimates, most of them being slightly below. Generally, the department rejects bids that are more than 10 percent above the estimates. The estimates had been increased between 20 and 25 percent for roadway work and about 35 percent for bridges, steel and lumber prices being raised 40 percent.

A curious sidelight on the bidding is the fact that several of the states have reported that bids on small jobs have been much farther above the engineers' estimate than bids on large jobs.

Bid rejections have not been as serious as the first reports indicated. In many instances the high bids were on small jobs, which, as previously noted, appear to be running high.

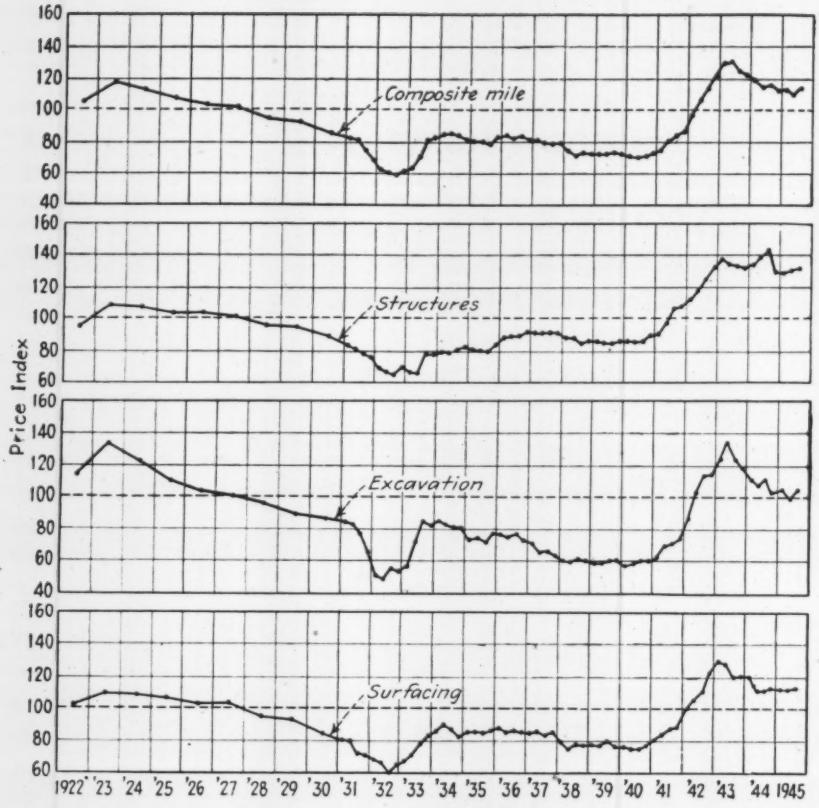


Fig. 3. Index of price trends on highway construction as compiled by the Public Roads Administration. Averages for the years 1925 to 1929 were taken as a base for the PRA index.

A few states like New York and Ohio have statutary requirements for rejection of bids that exceed the engineers' estimates by a specified amount, and some other state highway departments have set their own upper limit.

In dollar volume, the bid rejections on New York and Ohio appear to be the largest. New York's rejections have been noted above. Ohio got bids over the estimates on 64 projects, the average being 9 percent and the maximum 44 percent.

Engineers' estimates increased

When only average figures are given, the engineers' estimates as reported to us run from 15 to 50 percent above prewar. Where the figures are broken down, the estimates for structures go as high as 75 percent over the prewar figure. The average would seem to be a little over 30 percent.

Structures appear to be the high-cost item. As noted previously, on a $90,000 estimated bridge job, Maryland got a bid slightly over 120 percent in excess of the estimates. In Iowa, bridge and culvert work is expected to be 60 to 75 percent above prewar prices, whereas excavation costs are expected to be 50 percent higher and concrete paving between 25 and 30 percent above prewar.

Cost indexes

Increases in engineers' estimates averaging around 30 percent of prewar prices would appear to be in line with the rise in general construction indexes.

The Engineering News-Record construction-cost index is up 30 percent above the 1940 average. The index of the Associated General Contractors is up 22 percent, that of the American Appraisal Company is up 33 percent, Boeckh's index of factory costs in New York is up 18 percent, the Aberthaw Company's index is up 20 percent, the index of the Austin Company at Cleveland is up 47 percent, the Fuller and Turner indexes in New York are up 21 and 38 percent, respectively. These latter indexes relate chiefly to building costs.

The most extreme departure from prewar costs in the components of the ENR index is lumber, which is up practically 60 percent. Common labor is up 34 percent, skilled labor 14, and cement 11 percent. The cost of steel is the only item that has not gone up, but as the steel companies now claim that they are selling below cost under price control, it seems fairly reasonable to conclude that steel prices will go up before another construction season gets into full swing. The high bids for steel on the few bridge jobs that have been offered would appear to indicate that the fabricators are anticipating a rise in steel costs.

Cost data compiled by the Public Roads Administration reveal that in the third quarter of this year the average bid price on common excavation was 37¢. per cubic yard as against 21¢. in 1940. On concrete pavements, the price per square yard was $2.51 against $1.68 in 1940, and the bids on structural concrete were $31.60 against $19.17 in 1940.

The Public Roads Administration has maintained a price index for many years. It is of interest to note that except in the case of structures, this index reached a peak in 1943 and has been declining until just recently, when it began to show signs of a slow rise. The index for highway structures reached an all-time high last year but fell off sharply.

No major change in the price of cement appears imminent. Conceivably lumber might even come down in price, but in view of the critical housing situation that will not take place for some considerable time.

A few recent increases in labor rates in the 20 cities included in the Engineering News-Record cost index caused that index to rise four points or about one percent in December. The increase averaging 10 to 15 percent in construction labor rates at New York, approved by the Wage Adjustment Board just as the year closed, will send the index up about three more points in January.

No sharp rise in view

Viewing the situation broadly, there appears to be no reason for anticipating a sharp rise in costs within the next few months. Due to the slow rise in construction costs during recent months and the many uncertainties, however, it appears obvious that contractors bids must continue to anticipate some further increases in the cost of work to be undertaken this year. Consequently such bids probably will continue to be above engineers' estimates that are based solely on current costs.

Design Standards for the National System of Interstate Highways

***Contents in Brief**—Designation of a National System of Interstate Highways was authorized by Congress in 1944, and in the latter part of 1945 the American Association of State Highway Officials adopted design standards for that system. Those standards are given in the following and are compared with the standards for the projected system proposed at an earlier date by the National Interregional Highway Committee.*

FINAL PLANS for a 40,000-mi. system of arterial roads covering the United States are being actively implemented. Standards of design have been developed and location of routes is in progress. In the tension of building for war, the magnitude of the work has been only partly realized by engineers outside of federal and state highway administrations. It is not only a great postwar project; it is a commercial transportation development of unequalled magnitude. It contemplates a long-range development of a unified system of roads that is interstate and interregional, and by connecting at the boundaries with Canadian and Mexican main-road systems takes on aspects of an international highway plan. Location, design and construction are fixed on the high plane of peak traffic twenty years hence.

Since the early Twenties the thought of engineers has been concerned with promoting a national system of trunk-line or express highways. Articles in *Engineering News-Record* over the years have traced the developing steps of this ambitious idea. It is immaterial to retrace these steps, but now that the execution of the idea is actually under way some preface will help to an understanding of the factors that were involved in developing design standards for an interstate system.

Following the introduction into Congress in 1941 of the latest of the perennial bills to authorize an across-continent toll-road system, the President created the National Interregional Highway Committee to formulate a plan for a postwar program of interregional highway construction. Despite the fact that the Public Roads Administration in its 1939 report on "Toll and Free Roads" had declared against toll-road systems, strong forces

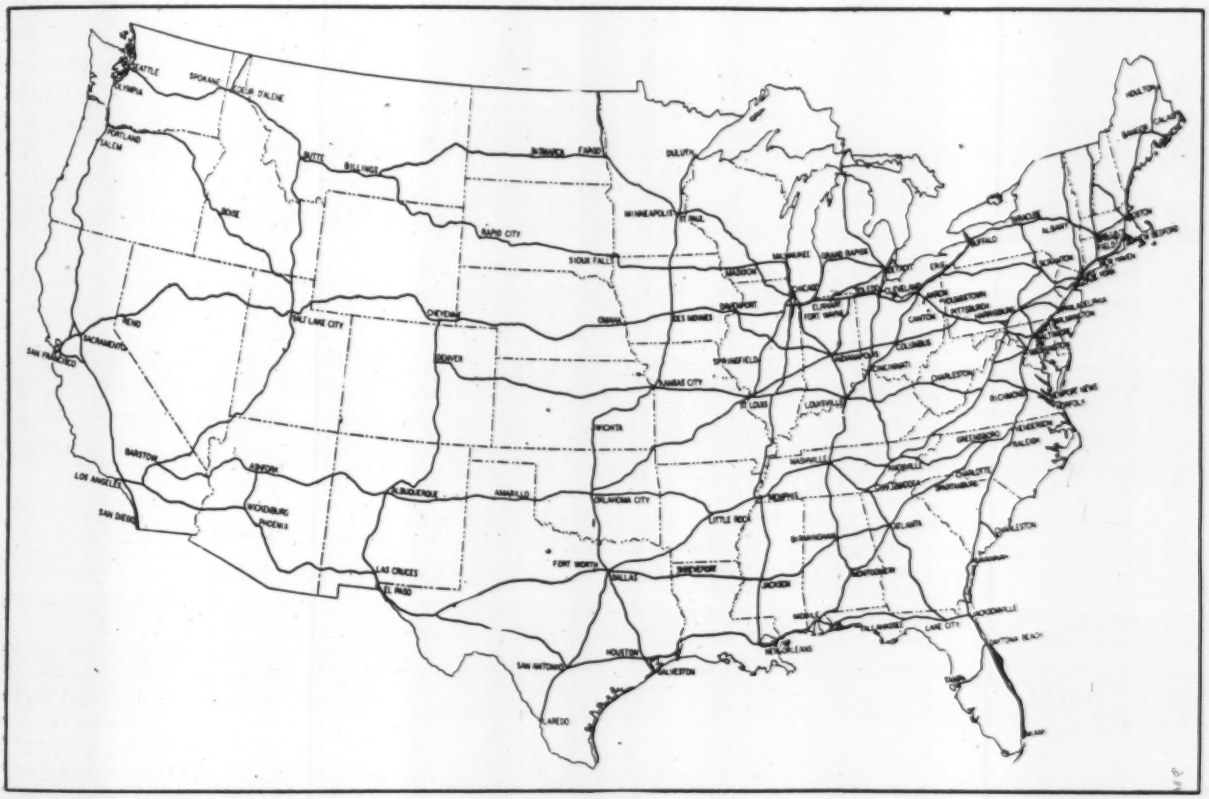


Fig. 1. General location of the National System of Interstate Highways proposed by the National Interregional Highway Committee. The highways now being designated by the state highway departments follow this pattern closely but will add about 6,000 miles to this total of 34,000.

in Congress and in the country still urged such construction. The new committee was expected to find a conclusion between the two ideas and to report a definite interregional road system.

The committee report was completed late in 1943 and its general conclusions were summarized in *Engineering News-Record*, Jan. 27, 1944, vol. p. 145. It was a comprehensive document. In general it advocated and mapped a free-road system of 33,930 mi., and indicated financing methods and costs. In detail it prescribed design controls and standards for the structure. These details were the work of the engineers and traffic students of the Public Roads Administration and may be regarded as the considered opinion of these experts as to what constituted desirable engineering requirements for the proposed roads.

The report of the interregional committee was put into effect by the Postwar Federal-Aid Highway Act of 1944, which said: "There shall be designated within the continental United States a National System of Interstate Highways not exceeding 40,000 mi. in total extent so located as to connect by routes as direct as practicable the principal metropolitan areas, cities and industrial centers; to serve the national defense, and to connect at suitable border points with roads of continental importance in the Dominion of Canada and the Republic of Mexico."

The act provided further that the routes shall be selected by the state highway departments in cooperation with the highway departments of adjoining states. When selected and approved all roads become parts of the federal-aid system. Planning for the system thus heads up in the Public Roads Administration in Washington. State highway administrations are brought into the planning as provided by the law and additionally by a cooperative agreement by which committees of the American Association of State Highway Officials will investigate and subsequently recommend operating procedures and standards to the federal authority.

TABLE I—DESIGN SPEEDS APPROVED BY THE A.A.S.H.O. FOR THE INTERSTATE SYSTEM.

	Miles per hour Minimum	Desirable
Rural Sections		
Flat topography	60	70
Rolling topography	50	60
Mountainous topography	40	50
Urban Sections	40	50

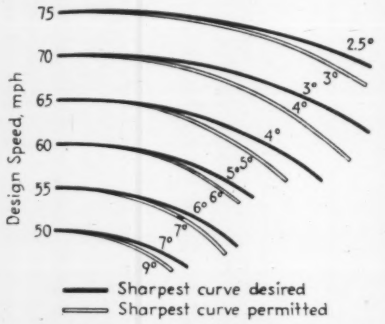


Fig. 3. Desirable and permissible degrees of line curvature recommended by the interregional committee for travel speeds of 50 to 75 mph. The A.A.S.H.O. committee made similar recommendations for speeds of 70, 60 and 50 mph., adding a recommendation of 14 deg. and 11 deg. as the maximum and desirable curvature for 40 mph.

In February of last year the Public Roads Administration asked each state highway department to proceed at once to determine the routes within its borders for the National System of Interregional Highways. At the close of 1944 most of the states had submitted maps and traffic data in support of their recommendations to the PRA. In general, those recommendations coincide closely with the routes recommended by the interregional committee, as shown in Fig. 1, but as the total mileage exceeds the authorized 40,000 and as proposed interstate connections frequently do not agree, it will be some time before the final details of the system can be announced.

Rigid conformity with a prescribed set of standards for this system is not to be required, according to the Public Roads Administration, but a high degree of uniformity will be sought by the PRA where conditions as to traffic, population density, topography and other factors are similar.

Under date of Aug. 1, 1945, the American Association of State Highway Officials issued its "Design Stand-

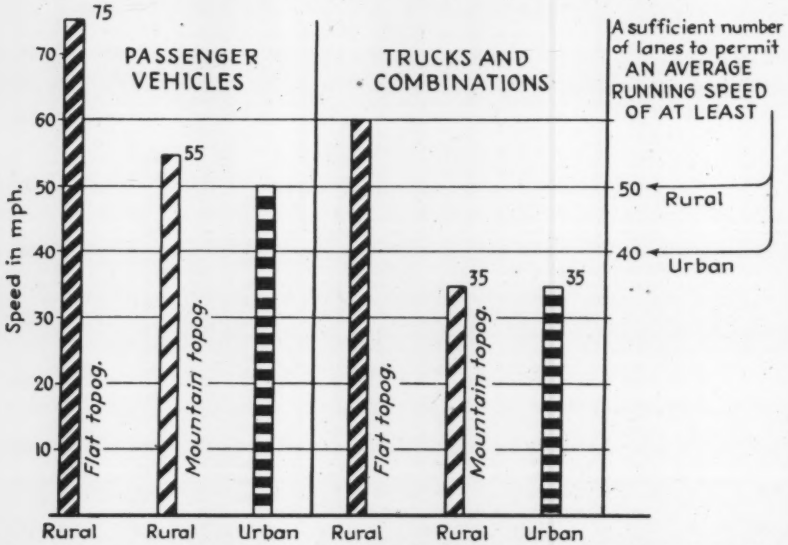


Fig. 2. Design speeds proposed by the National Interregional Highway Committee. They are somewhat higher for rural sections than those set by the A.A.S.H.O., as will be seen by reference to Table I.

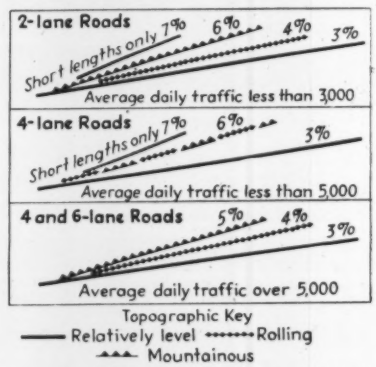


Fig. 4. Allowable gradients recommended by the interregional committee for different volumes of traffic and road widths in flat, rolling and mountainous country. The A.A.S.H.O. committee recommends simply that the "maximum gradient preferably shall not exceed 5 percent and in any case shall not exceed 6 percent. On short lengths only, gradients of 7 percent may be used."

ards for the National System of Interstate Highways," which had been approved by the 52 member departments of the association. Prepared by the association's Committee on Planning and Design Standards, these new standards were characterized by the committee as a "set of values or controls the use of which is intended to produce highway facilities that represent the best practice." In general, the report also says, "the basic standards of road and structural design in the report of the National Interregional Highway Committee are recognized as embodying the elements of design to produce the highway facilities that now appear necessary for the limited mileage of highways to be designated the National System of Interstate Highways."

In view of the fact that the A.A.S.H.O. characterizes these standards as representing best practice and at the same time accepts the standards set by the National Interregional Highway Committee in 1943, they are compared with the interregional committee's standards in the following text and the acompanying graphs.

Both standards are developed on the basis that all routes, rural or urban, will serve a mixed traffic of passenger automobiles, motor-buses and motor-trucks, and tractor-trailer or semi-trailer combinations of a volume of each estimated to be that which will exist 20 years after construction. Initial construction may be only that to carry present or immediate future traffic, but it must be patterned to be a usable part of the ultimate structure. In general the values named are set up as minimums, but modification or departure when conditions make lower values necessary is recognized.

Designed for high speeds

The standards set are directed toward high-speed traffic. Speeds on which the A.A.S.H.O. standards are based are given in Table I, while those of the interregional committee are shown graphically in Fig. 2. As will be seen, the interregional committee based its recommendations on somewhat higher speeds for passenger vehicles than those set by the highway officials. The latter made no recommendation with respect to truck speeds.

Average speeds were indicated by the interregional committee. As given, the average running speed is the overall speed of a single vehicle over some length of the system; it is not the arithmetical mean speed of all vehicles passing a single point on the highway. The average running speed is closely related to traffic volume and the number of lanes as well as to the design speeds, passing sight-distance restrictions and gradients. It is not expected that such running speeds will be attained during the infrequent hours of maximum traffic volume.

Line and grade controls for these design speeds, in the highway officials report, are as follows: All curves sharper than 1 deg. are to be superelevated and all sharper than 2 deg. are to be designed with approach transition curves. The maximum degree of curve consistent with design speeds is set at:

Speed mph.	Maximum deg.	Desirable deg.
70	4	3
60	6	5
50	9	7
40	14	11

Corresponding speed-curve values set by the interregional committee report are shown by Fig. 3. They are

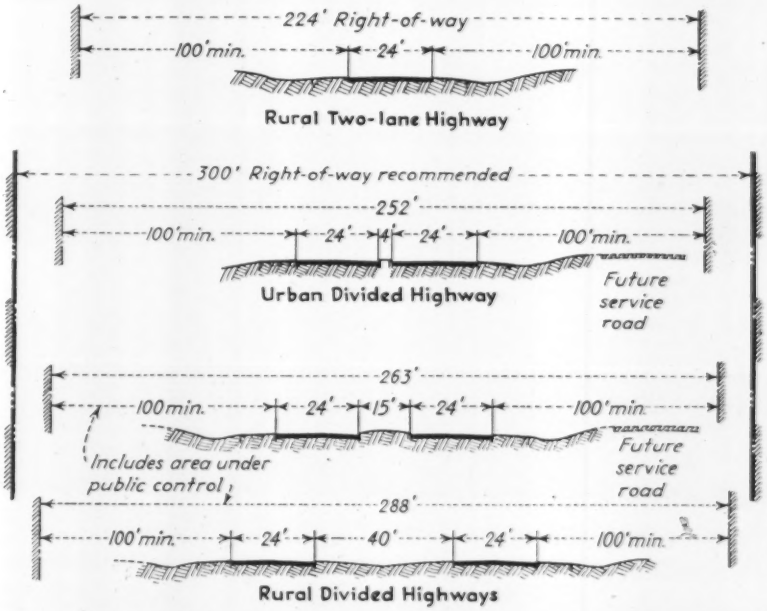


Fig. 5. Widths of right-of-way and standard rural-road sections proposed by the interregional committee for rural and urban highways.

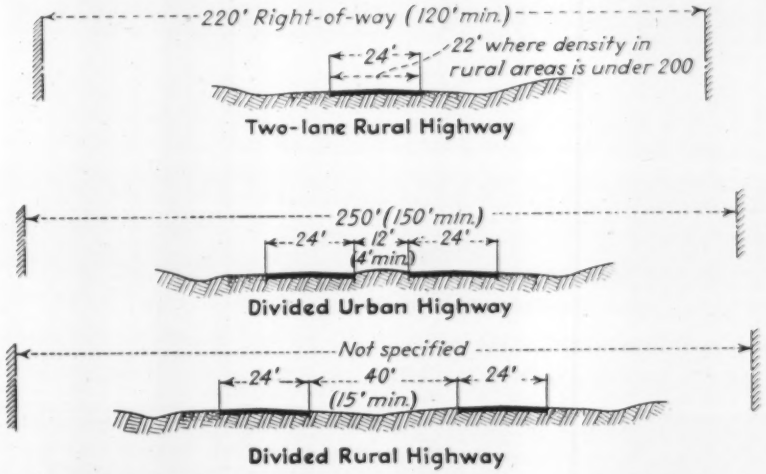


Fig. 6. Standard right-of-way widths and sections approved by the A.A.S.H.O. committee are similar to those of the interregional committee except that right-of-way widths are less liberal.

specified for more speeds and for a higher top speed but for no lower speeds than 50 mph. Also, the reservation is made that flatter curves may be necessary to meet sight-distance requirements.

Grades and sight distances

In respect to limiting grades, the highway officials' recommendations are very terse. The maximum grade "preferably shall not exceed 5 percent and in any case shall not exceed 6 percent." Then, contradictorily, is the statement: "On short lengths only, gradients of 7 percent may be used."

Here again the interregional committee values are in more detail. As shown by Fig. 4, permissible grades vary with topography, volume of traffic and number of travel lanes. It is stated that the values shown should be used as an *infrequent maximum* rather than as a repeated control gradient.

On the vital specification for sight distance the highway officials' say: "Sight distance commensurate with the type of highway and the design speed shall be provided as shown in A Policy on Sight Distance for Highways," which is a 25-page document prepared by the association and published in 1940. A summary of those finding is given in Table II, while the sight distances proposed by the interregional committee are set forth in Table III.

The non-passing values apply to both horizontal and vertical curves and measurement is from the driver's eye (4.5 ft. above the pavement) to a 4-in. high block on the pavement. For passing, the measurement is that between approaching vehicles and applies to vertical curves.

TABLE II—SIGHT DISTANCES RECOMMENDED BY THE A.A.S.H.O. IN ITS PAMPHLET "A POLICY ON SIGHT DISTANCES FOR HIGHWAYS."

Design speeds mph.	Minimum, non-passing feet	Two-lane highways: Minimum, passing Desirable feet	Two-lane highways: Minimum, passing Absolute feet	Three-lane highways: Minimum, passing Desirable feet	Three-lane highways: Minimum, passing Absolute feet
30	200	600	500		
40	275	1,100	900		
50	350	1,600	1,400	1,100	900
60	475	2,300	2,100	1,500	1,300
70	600	3,200	2,900	2,000	1,800

TABLE III—SIGHT DISTANCES RECOMMENDED BY THE NATIONAL INTERREGIONAL HIGHWAY COMMITTEE.

Design Speeds mph.	Non passing feet	Passing feet
50	400	1,500
55	450	1,800
60	525	2,200
65	610	2,600
70	700	*
75	800	*

* Normal passing not considered safe at 70-mi. and 75-mi. speeds.

Roadway design standards

Specific right-of-way widths are named in the highway officials report for rural sections of the road only, as shown in Fig. 6. For urban sections, widths cannot well be specified because of variable conditions, but it is stated, provision should be made from the beginning for all the width required for the ultimate design.

Considerably more liberal right-of-way zones were called for in the interregional committee report, as shown by Fig. 5. Whatever the type of road, public control is required of a width of land to 100 ft. beyond the outer pavement edges on each side. Going even further, a 300-ft. right-of-way is recommended for all divided roads.

Shoulder widths and side slopes recommended in both reports are quite similar. Shoulder widths required by the highway officials' standards are at least 10 ft. except in mountainous country where the minimum is 4 ft. Side slopes are not to be steeper than 1 on 2 except in rock or other stable material that justify steeper slopes. On fills of less than 10 ft., the steepest slope is to be 1 on 4.

Details of shoulder design are more fully described in the interregional committee report, as indicated by Fig. 7. Slopes are very carefully set forth, a particular detail being the specification of warped slopes from cut to fill.

The interregional committee states that the sides of all excavations shall be rounded at the top and bottom to merge by curves of natural appearance into the slopes of the adjoining land and those of the gutters or ditches. At the ends of sections in excavation the side slopes shall be flattened as the depth of excavation decreases.

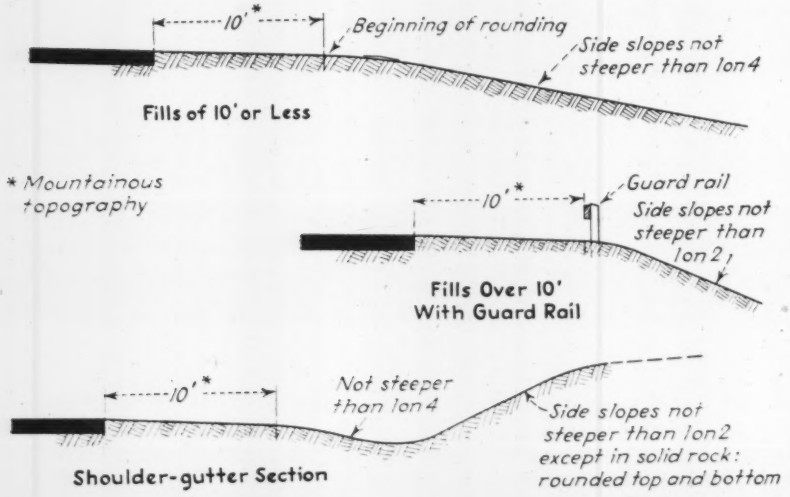

10'*
Beginning of rounding
Side slopes not steeper than 1on4
Fills of 10' or Less
* Mountainous topography
10'*
Guard rail
Side slopes not steeper than 1on2
Fills Over 10' With Guard Rail
10'*
Not steeper than 1on4
Side slopes not steeper than 1on2 except in solid rock: rounded top and bottom
Shoulder-gutter Section

Fig. 7. Wide shoulders and gentle ditch and side slopes, with rounded edges, were called for by the interregional committee.

Lane widths

When the hourly traffic density, present or anticipated, is less than 200, the highway officials' committee recommends lane widths of 11 ft.; and for densities greater than 200 and on all urban sections, lane widths of 12 ft. For densities of 500 or greater a divided highway is called for, with median-strip widths in feet as follows:

Type	Minimum, feet	Desirable, feet
Rural	15	40
Urban	4	12

Under conditions of economic necessity, a median strip width of 2 ft.,

may be used on urban sections while recognizing a 4-ft. width as desirable under those conditions.

Fig. 5 shows the pavement standards for rural roads as recommended by the interregional committee for traffic volumes up to 15,000 daily. For heavier traffic on urban sections, additional traffic lanes making a six-lane road are contemplated.

Limited access

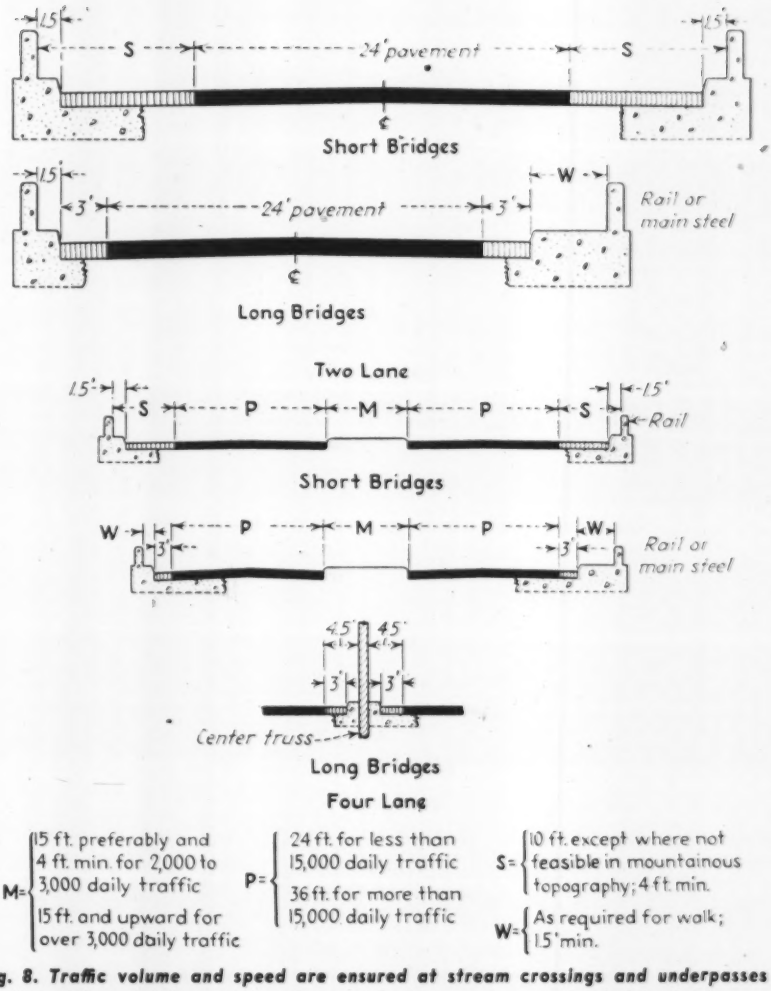
The distinctive feature of the projected system of highways is control over access wherever that is possible. Crossings and traffic interchanges are planned to that end. As defined in the highway officials' recommendations, controlled access means "the permission of access to and from adjacent property at certain locations and for certain purposes and the permission of interchange with selected intersecting streets and roads." The physical means may be service roads, ramps, clover-leafs, or other accepted construction.

The highway officials recommend that where state laws permit, control of access shall be obtained on all new locations and on all old locations where economically possible. In states where there is no law authorizing acquisitions of access rights, the highway officials recommend the purchase of additional right-of-way to permit construction of "frontage roads" connecting with controlled-access points.

Railway crossings

At crossings of two or more mainline tracks, the highway officials state that separation should be provided regardless of traffic volume on the highway. Similarly, where there are six or more regular movements per day over a single track, separation should be mandatory regardless of highway traffic volume. If there are less trains, grades should be separated when economic analysis indicates justifications. Protective devices should be installed where grades are not separated.

For road crossings it is recommended that, for a traffic of 3,000 or more vehicles per day, every effort shall be made to eliminate all cross traffic at grade. For less traffic, cross-traffic shall be eliminated when justified by economy, delay, hazard and convenience. Where cross-traffic at grade is not eliminated, traffic signal control installations, channelized intersections, or stop control on the crossing road are to be provided.



M = 15 ft. preferably and 4 ft. min. for 2,000 to 3,000 daily traffic; 15 ft. and upward for over 3,000 daily traffic

P = 24 ft. for less than 15,000 daily traffic; 36 ft. for more than 15,000 daily traffic

S = 10 ft. except where not feasible in mountainous topography; 4 ft. min.

W = As required for walk; 1.5' min.

Fig. 8. Traffic volume and speed are ensured at stream crossings and underpasses by the widths of fully paved surfaces and clearances recommended by both committees. These drawings show the dimensions recommended by the interregional committee. The A.A.S.H.O. recommendations are identical in most instances.

Bridges and underpasses

Design controls for bridges and underpasses recommended by the A.A.S.H.O. relate largely to roadway widths and clearances. Crossings of 20 ft. or less in span are classed as culverts and are to carry the full width of pavement and shoulders. Bridges are to be steel, concrete or masonry and preferably deck structures. Clearances are to be 14 ft. over pavement and 12½ ft. over the effective shoulder width. Lateral clearances from the right edge of pavements of through traffic lanes to the face of walls, abutments or piers shall be at least 6 ft.; left edge clearances to a center pier or abutment shall not be less than 4½ ft.

For bridges up to 80 ft. in length, the clear width is to equal the full pavement and effective shoulder width. For longer bridges the width required is full pavement width with clearances or preferably 3' ft. but always 2 ft. to curbs and preferably 4½ ft. but always 3½ ft. to rails. Sidewalks are required where pedestrian traffic justifies.

The interregional committee bridge-width standards corresponding to those just named are shown by Fig. 8. Both the highway officials and the interregional committee recommend that all structures be designed for the associations loadings known as H20-S16.

The Highway Transport Committee of the A.A.S.H.O. has not yet made its final recommendations with respect to motor vehicle size and weight limits for the interstate system. The limits that now are being considered are given in the article that follows.

Progress Being Made Toward Uniformity In Truck Size and Weight Limits

Contents in Brief—*Progress made during 1945 toward obtaining greater uniformity in state restrictions on motor vehicle size and weight is briefly summarized, bringing up to date information contained in a fuller statement on this subject published in the issue of Jan. 11, 1945. Supplementing this is a statement on the subject by the state highway engineer of Oregon.*

DETERMINATION of appropriate size and weight limitations for motor vehicles operating over public highways continues to be a major issue before highway engineers, due principally to the fact that such standards have yet to be set for the National System of Interstate Highways that is part of the postwar highway program authorized by Congress. Also, no agreement has yet been reached between the highway builders and the operators of motor vehicles as to acceptable standards either for that limited system or for the much larger federal-aid system.

Some progress toward agreement appears to have been made since this subject was reviewed at length in these pages a year ago (*ENR* Jan. 11, 1945, vol. p. 24). Progress toward uniformity in state laws regulating the size and weight of motor vehicles also was made, an unusually large number of amendments to state laws having been passed during the year.

Outstanding among the year's developments was a series of conferences between the Highway Transport Committee of the American Association of State Highway Officials and representatives of the operators and manufacturers of motor vehicles. These meetings were arranged to give the operators and makers of motor vehicles an opportunity to consider and comment on tentative size and weight standards for the National System of Interstate Highways prepared by the A.A.S.H.O. committee for submission to the association before those tentative standards were approved by the committee.

Details of the standards that the A.A.S.H.O. committee laid before the automotive organizations have not been made public, but it is to be assumed that they follow closely those discussed by the transport committee at its meeting in December, 1944, which are given in Table IV.

Comment by the automotive organizations is now being considered by the Highway Transport Committee, after which the committee's final recommendations will be sent out to the 48 state highway departments for approval as an association standard. It is anticipated that this will be done before the A.A.S.H.O. meeting late this month.

Standards proposed last year by the American Trucking Associations for the projected National System of Interstate Highways are given in Table II During the year, certain truck and bus operators attending the Midwest Uniformity Conference at Madison, Wis., proposed further increases, namely 20,000 lb. axle loads, 34,000 lb. on tandem axles, 89,000 lb. gross weight, 102-in. width, 14-ft. height, 40-ft. length for single unit, 50 ft. for tractor-semitrailers and 65 ft. for combinations. What the reaction of the national associations of bus and truck operators will be to these proposals is not known.

Amendments to laws controlling size and weight of motor vehicles were introduced in the legislatures of 34 states, according to the National Highway Users Conference. Delaware, Nebraska, Oregon and Vermont enacted extensions of the emergency temporary increases in weight limits and Pennsylvania made its increase permanent.

Arizona now determines gross weight by the formula given in Table I, using coefficients of 750 and 800. California adopted a table of gross weights based on the use of coefficients of 700 and 800 in the gross-weight formula. Colorado and Minnesota increased the

TABLE I—VEHICLE SIZE AND WEIGHT LIMITS RECOMMENDED BY THE NATIONAL INTERREGIONAL HIGHWAY COMMITTEE.

Width	96 in.
Height	12½ ft.
Length (over-all, including bumpers and load)	
(1) single vehicles	35 ft.
(2) tractor-semitrailer combinations	50 ft.
(3) other combinations	60 ft.
Axle load	18,000 lb.
Gross weight	
On any vehicle or combination of vehicles according to the formula $W = C\ (L + 40)$	
In which:	
W = gross weight of vehicle in pounds.	
L = length in feet between the forward and rear axles of the vehicle or combination of vehicles or any group of axles thereof.	
C = a coefficient with the following values:	
For values of L less than 18 ft	650
For values of L equal to or greater than 18 ft	750

TABLE II—STANDARDS FOR SIZE AND WEIGHT PROPOSED BY THE AMERICAN TRUCKING ASSOCIATIONS.

Width, over-all	102 in.
Width, body	96 in.
Height	13½ ft.
Length (1) single vehicle	40 ft.
(2) tractor semitrailer	50 ft.
(3) other combinations	65 ft.
Axle loads (1) on high-pressure tires	18,000 lb.
(2) on balloon tires	20,000 lb.
Gross weight according to the formula $W = C\ (L + 40)$ in which:	
C = 750 where L is less than 18 ft.	
C = 850 where L is equal to or greater than 18 ft.	

higher coefficient from 700 to 750, North Dakota adopted the 750 coefficient, and Wyoming raised its upper coefficient to 850, the figure favored by the American Trucking Associations.

Numerous states made increases in axle loads or in gross weight for single vehicles or combinations.

Arizona increased the permissible vehicle width from 96 to 102 in., the width advocated by the A.T.A. Connecticut, and Rhode Island have a similar width limit, and Colorado, Massachusetts, and Michigan permit that width at rear tires when solid tires are changed to pneumatics. New York has a limit of 106 in. and New Mexico sets it at 100 in.

Arizona reduced its height limit from 14½ ft. to 13½ ft., the limit sought by the A.T.A. and now accepted in 10 states. Tennessee and Vermont raised their height limits to 12½ ft., the limit recommended by the National Interregional Highway Committee. All states now have the 12½-ft. limit or greater, either by statute or governor's proclamation.

Special Permit System Proposed For Heavy Trucks on Arterial Roads

R. H. BALDOCK
State Highway Engineer of Oregon,
Salem, Ore.

FOR MANY YEARS the subject of limitations of weight and dimension of motor vehicles has been a highly controversial one and lack of uniformity in the laws which govern these limitations in the various states has resulted in trade barriers which are inimical to the general welfare of the people.

For the past twelve years, the writer has given much thought to this subject. In 1936, he presented the matter before the Western Association of State Highway Officials in an endeavor to formulate a uniform specification of the sizes and weights of motor vehicles operating in the western region of the United States. At the Denver meeting in 1937, an interim committee was appointed to bring in a report to the annual meeting of the association at Reno, Nev., in 1938.

In the meantime the subject had been given considerable study in Oregon and, as a result of that study and investigation, Technical Bulletin No. 6, entitled "The Effect of Heavy Motor Transport on Highway Bridge Stresses," was published and circulated among the western states. The data was examined by the bridge departments of the several states and by A. L. Gemeny, then the bridge engineer for the Public Roads Administration, and the conclusions were concurred in by all parties.

In 1938, at Reno, the Western Association went on record by resolution favoring the adoption of uniform laws with respect to sizes and weights of motor vehicles. The specifications, as set forth at the Reno conference, approximated the specifications later promulgated by the National Interregional Highway Committee, appointed by the President in 1943 (*ENR* Jan. 27, 1944, vol. p. 146). In 1938, California and Nevada were the only western states that had laws approximating the Reno conference recommendations. Subsequent to that time, both Washington and Idaho adopted the recommendations proposed at the Reno conference, and in California the weights were increased somewhat over those recommendations.

The Reno conference recommendations for vehicle sizes and weights are given in Table III.

Unfortunately, prior to the war, the legislature of the state of Oregon refused to change the Oregon laws, but, during the period of the war, the legislature granted the Oregon State Highway Commission power to promulgate rules and regulations permitting the operation of overweight and oversize vehicles during the war emergency. The rules and regulations adopted by the Oregon State Highway Commission are practically identical with the recommendations embraced in the resolution of the Western Association of State Highway Officials passed at Reno in 1938.

The writer has also served for many years on the Highway Transport Committee of the American Association of State Highway Officials. At the Cincinnati meeting in December 1944, the committee again considered the subject and sent out for letter ballot a revision of weights and dimensions, approximately as adopted by the interregional committee, as given in Table IV.

At the present time, Oregon statutes permit the operation of motor vehicles as given in Table V.

Under the authority of the 1943 Oregon Legislature, the State Highway Commission of Oregon permits the operation of vehicles over Group No. 1 highways whose geometric design is such that the longer vehicles can stay on the right-hand side of the centerline stripe on all occasions, as given under Table VI.

The National Interregional Highway Committee recommends weights and dimensions as given in Table I.

Regional agreements possible

It is recognized that it is difficult to reconcile divergent opinions on this subject, but a step in the direction of uniformity could be secured by regional agreements and the passing of the requisite legislation in the states of the region looking toward eventual national uniformity. The subject might be broken down into two main categories: first, the proper standards for weights and dimensions of motor ve-

TABLE III—VEHICLE AND WEIGHT LIMITS PROPOSED AT THE RENO CONFERENCE IN 1938.

Width	96 in.
Height	13½ ft.
Length (1) single vehicle	35 ft.
(2) combination	60 ft.
Axle load	18,000 lb.
Gross weight according to the formula $W = C(L + 40)$ In which:	
W = gross weight of vehicle in pounds.	
L = length in feet between the forward and rear axles of the vehicle or combination of vehicles or any group of axles thereof.	
C = a coefficient with the following values:	
For values of L less than 18 ft	650
For values of L equal to or greater than 18 ft	750

hicles operating over state highways that are now constructed; second, the determination of standards of highway design relating to the weights and dimensions of motor vehicles to be operated over the highways of the future.

It is axiomatic that it is necessary to correlate the design of the highways and the design of the vehicle. Since we now have a road system and, in view of the fact that the highway facilities last so much longer than motor vehicles, it is impossible to make changes in highway design with the same frequency that changes in motor-vehicle design can be accomplished. Therefore, it seems sensible to permit the operation over present highways of the heaviest, longest and widest vehicle that the facilities will permit, due regard being given to the structural design of the pavement and bridges and to the geometric design of the highways in relation to the preservation of the investment of the public and the safeguarding of the lives of the people.

Many years ago it was decided to design highway pavements to support 18,000-lb. axle loads and to design bridges for the H-15 specification. The earlier pavements and some of the bridges were not wide enough to permit the safe passing of two 8-ft. vehicles. Gradually through the years most of the pavements and bridges have been widened to provide for the safe passing of vehicles 8 ft. in width, but limited finances have prevented any radical changes in design to afford load-carrying capacities of either the pavements or the bridges beyond the selected limits. In the meantime, the demand for greater pay-load capacities resulted in the design of larger and larger trucks.

Ton-mile tax proposed

As pointed out before, highway facilities, unfortunately, cannot change with the frequency of truck design. It would appear axiomatic that, since the larger dimension and heavier vehicles require a design based on wider and stronger pavements and wider and heavier bridges, necessitating the expenditure of additional construction funds, those who own and operate the heavier vehicles should pay the extra cost of the facilities required to carry them. The public builds the roads and rents the use of the roads to private individuals who should pay a ton-mile tax in relation to use and in proportion to the costs of the facilities provided for them.

It is the considered opinion of the writer that the full use of each highway for the transportation of goods and trucks, including commercial transports, logging trucks, farm trucks etc., should be afforded, and that limits on weights and dimensions should be placed as high as the structural and geometric design of the individual highway will permit without damage to the highway and without increased traffic hazard. Action to that end would be in the public interest and would reduce the cost of the transportation of goods in both intrastate and interstate commerce. The savings in cost of transportation under the inflexible laws of competition would rapidly be passed on to the consumer.

There is a tendency on the part of truckers and manufacturers to cry for uniformity and at the same time to seek increase in weights and dimensions over and above the agreed reasonable limits. Also, there is a constant effort on the part of some truck operators to resist the imposition of fair taxes for the use of the facilities provided. Such tactics have undoubtedly been a main reason why uniform regulations on sizes and weights have not been adopted in the past. It would seem that the solution of this problem should be based upon factual determination of the maximum weights and sizes of vehicles with respect to structural and geometric design and, in like manner, that the fees and taxes should be based upon the cost of providing the stronger and wider highway facilities for the larger and heavier trucks.

Longer vehicles and combinations

To permit an increase in the gross weight of a train of vehicles and load without increasing the risk of damage to the highway facilities, it is necessary to increase the permissible length of a train of vehicles by a reasonable amount and to require the use of more axles. This, in turn, reduces the individual axle load and the structural stresses imposed thereby. Increase in length of vehicle or combination thereof can be permitted, however, only when the alignment of the road is sufficiently straight and the pavement is sufficiently wide.

Some increase in design standards for the main traffic arterials, including the interstate system, to provide more economical transportation in the fu-

TABLE IV—STANDARDS PROPOSED BY THE HIGHWAY TRANSPORT COMMITTEE OF THE A.A.S.H.O. IN DECEMBER 1944.

Width	96 in.
Height	12½ ft.
Length (1) single vehicle	35 ft.
(2) tractor and semitrailer	45 ft.
(3) other combinations	60 ft.
Axle load	18,000 lb.

(Note: An axle load shall be defined as the total load transmitted to the road by all wheels whose centers may be included between two parallel transverse vertical planes 40-in. apart, extending across the full width of the vehicle.)

No group of axles shall carry a load in pounds in excess of the value given in the following table corresponding to the distance in feet between the extreme axles of the group, measured longitudinally to the nearest foot:

Distance in feet between the extremes of any group of axles	Maximum load in pounds carried on any group of axles	Distance in feet between the extremes of any group of axles	Maximum load in pounds carried on any group of axles
4	32,000	32	54,328
6	32,000	34	55,982
8	32,608	36	57,612
10	34,550	38	59,218
12	36,468	40	60,800
14	38,362	42	62,358
16	40,232	44	63,892
18	42,078	46	65,402
20	43,900	48	66,888
22	45,698	50	68,350
24	47,472	52	69,788
26	49,222	54	71,202
28	50,948	56	72,592
30	52,650	57	73,278

The maximum axle and axle-group loads recommended above are subject to reasonable reduction in the discretion of the appropriate highway authorities during periods when road subgrades have been weakened by water saturation or other cause.

The operation of vehicles or combinations of vehicles having dimensions or weights in excess of the maximum limits herein recommended shall be permitted only if authorized by special certificate issued by an appropriate state authority.

ture appears to be in order so that this nation may continue in the march of progress. It is the opinion of the writer that this new standard cannot be confined to the interstate system because of the impracticability of confining the larger vehicles to this limited mileage. However, it does appear to be practical to confine such movement to the main traffic arterials through the issuance of permits by the proper authority for the continued movement of such vehicles over a definite system of roads. The Oregon State Highway Commission has satisfactorily carried on this arrangement with respect to the emergency wartime permits.

Arterial system permits

In conclusion, the writer would recommend the adoption for the present of the schedules of weights and dimensions of motor vehicles, as proposed by the Highway Transport Committee of the American Association of State Highway Officials (Table IV) for operation under permit over the main arterial system in each state.

It is the personal opinion of the writer that the over-all vehicle width of 102 in., limiting body width to 96 in., would bring about a safer and better designed vehicle with less side sway and that present design standards could safely accommodate it.

It is apparent that the secondary and tertiary roads of the system for economic reasons cannot, in many cases, be designed and constructed to the high standard required for the heavier and wider vehicles, but, with respect to the main arterial system, such roads have been designed to comparable standards throughout the United States and are adequate structurally and geometrically to carry such vehicles. The secondary roads may not be so constructed as to permit the operation of the longer vehicles, but the operation over the main arterial routes can be handled by the permit system. As more roads are improved, they can be added to the system.

It will probably take at least 25 years to build the interstate system and to improve the main traffic arterials in the states to the structural and geometric standards proposed by the National Interregional Highway Committee and, in the interim, vehicles operating over the selected system of main arterials must be held to the maximum sizes and weights specified in Table IV. As soon as bridges on the said system have been rebuilt to the H-20 S-16 standards, attention can be given to the resurfacing of pavements to bear additional wheel and axle loads. The geometric design of such a system will also permit some increase in the length of the train of vehicles. At that time the vehicle sizes and weights recommended by the American Trucking Associations, as given in Table II, may be permitted over the system of arterial highways which has been designed and constructed to carry them.

In short, it would seem to the writer that it is now possible to permit the operation of vehicles of the sizes and weights given in Table IV over the main arterial highway systems in the several states by means of a permit system which will enable vehicles to operate over and above the statute requirements on a limited system of roads. It would, moreover, seem desirable, during the next quarter of a century, to design and construct the same arterial system to carry vehicles of the sizes and weights shown in Table II. In the meantime, the operators and manufacturers must be patient and be willing to conform with such restrictions, must pay their fair share of the cost of such facilities and agree that, when the revisions are made permitting the operation of larger vehicles, the weights and dimensions of such vehicles will be static for a long period of time.

TABLE V—DIMENSIONS AND LOAD LIMITS FOR VEHICLES NOW IN EFFECT ON ALL HIGHWAYS IN OREGON.

Width	96 in.
Height	12½ ft.
Length (1) single vehicle	35 ft.
(2) tractor-semitrailer combination	50 ft.
(3) other combinations	50 ft.
Axle load	18,000 lb.

Gross weight according to the formula $W = 700 (L + 40)$

TABLE VI—HIGHER STANDARDS PERMITTED FOR VEHICLES OPERATING OVER GROUP 1 HIGHWAYS IN OREGON.

Width	96 in.
Height	12½ ft.
Length (1) single vehicle	35 ft.
(2) truck-tractor semitrailer combination	50 ft.
(3) other combinations	60 ft.
Axle load	18,000 lb.

Gross weight:

(1) The gross weight of any group of axles spaced 18 ft. or less apart shall not exceed that given in the following table, provided that the gross weight of any single axle of such group shall not exceed 18,000 lb., and any two axles spaced less than 3 ft. 6 in. shall be considered to be one axle for the purpose of determining gross weight:

Distance between first and last axles of group	Maximum gross weight of group (Pounds)	Distance between first and last axles of group	Maximum gross weight of group (Pounds)
Less than 10′	32,000	14′	35,100
10′	32,500	15′	35,750
11′	33,150	16′	36,400
12′	33,800	17′	37,050
13′	34,450	18′	37,700

(2) The gross weight of any group of axles spaced more than 18 feet apart shall not exceed that given in the following table, provided that the gross weight of any single axle of such group shall not exceed 18,000 lb., and any two axles of such group spaced less than 3 ft. 6 in. apart shall be considered to be one axle for the purpose of determining weight:

Distance between first and last axles of vehicle or combination	Maximum gross weight of vehicle or combination (Pounds)	Distance between first and last axles of vehicle or combination	Maximum gross weight of vehicle or combination (Pounds)
Over 18′ but less than 19′	44,250	37′	57,750
19′	44,250	39′	59,250
21′	45,750	41′	60,750
23′	47,250	43′	62,250
25′	48,750	45′	63,750
27′	50,250	47′	65,250
29′	51,750	49′	66,750
31′	53,250	51′	68,250
33′	54,750	53′	69,750
35′	56,250	55′	71,250

The maximum gross weights given in each of the above tables have been calculated for axle spacings to the nearest foot. If the axle spacing as actually measured is fractional the gross weight allowed is that given in the table for the next higher spacing.

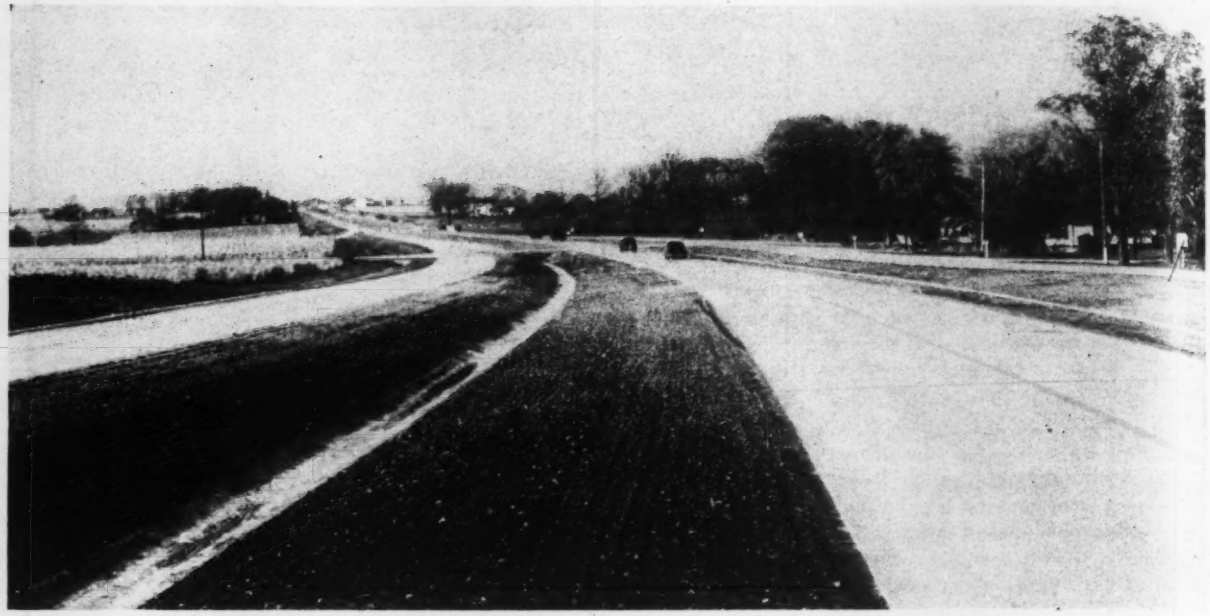


Fig. 1. Reconstruction of Illinois U. S. Highway 66 envisions a four-lane divided highway from St. Louis to Chicago.

Illinois Rebuilds U.S. Highway 66

***Contents in Brief**—Three important requirements of modern highway design are incorporated in the new construction on U. S. Highway 66 between St. Louis and Chicago. They are, (1) belt-line construction to bypass all but the smaller towns along the highway, (2) limited access and (3) subgrade preparation to prevent future pavement pumping.*

ILLINOIS' new four-lane freeway (U. S. Highway 66) running from St. Louis, Mo. diagonally across the state to Chicago will be fast, safe and durable. Both speed and safety are being incorporated by separating the two 24-ft. concrete pavements, bypassing towns of any appreciable size, and by limiting the number of points of access to the highway.

Durability and long life are assured the new concrete pavement by blanketing the compacted subgrade with a layer of granular material to guard against pavement pumping during wet weather; chief cause of failure for many existing highway pavements throughout the country.

Simplicity of design, economical utilization of existing stretches of pavement, and flexibility of construction procedure—all are to be found in the over-all improvement plan for this heavily-traveled trunk highway. The two chief characteristics of the new work are "divide" and "bypass"—wherever feasible the new pavement is built parallel to, and separated from, sections of structurally sound old pavement having adequate width, proper curvature and alignment. And several towns and cities along the route are being bypassed with new belt lines to obviate the necessity of expensive grade interchange connections.

It could be said that principles of design and construction adopted in improving U. S. Highway 66 through Illinois are the culmination of the state highway department's experience in road building throughout the past two decades. Several of the department's key personnel have grown up with highway construction in Illinois.

Based on years of experience, these engineers know just what type of construction is needed to withstand the climatic conditions peculiar to that state, how best to prepare the subgrade to insure long life in a concrete pavement, and what grades, curvature and other physical features of modern highway construction are needed to safely handle high-speed passenger car and heavily loaded truck traffic. Such a highway, is the new improved portion of Illinois U. S. Highway 66.

Despite wartime restrictions on road-building materials, considerable recon-

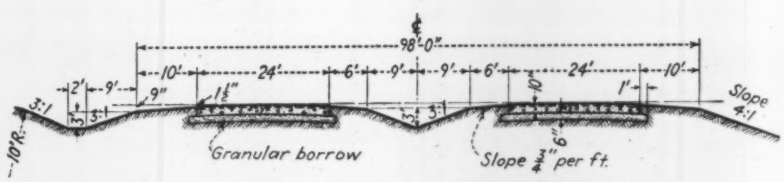


Fig. 2. New pavements on U. S. Highway 66 are 10 in. thick, 24 ft. wide on a 6-in. granular subbase and separated by wide medians wherever feasible.

struction of this highway was prosecuted during the past four years. Heavy wartime truck traffic damaged several sections of the old pavement, most of which were built in the early 1920's, far beyond the point of economical maintenance. Approval of the War Production Board for new construction was secured, in several instances, by showing that even in man-hours alone, the cost of constructing a new pavement was less than the expense of rehabilitating and maintaining one that was badly worn out.

Wartime construction

There was not a great deal of new pavement constructed on U. S. Highway 66 in Illinois during the first year of the war. The largest project in 1942 was a 10-mile dual pavement forming the belt line around Bloomington, Ill.

During 1942 and 1943, however, sections of the old pavement wore out so rapidly under heavy truck traffic that it was necessary to reconstruct 75 miles, costing a total of $6,400,000. These sections were located just south of Joliet, between Gardner and Pontiac, and from S.B.I. (state bond issue) Route 48 to Staunton. There was very little new pavement constructed in 1944, but several sections were put under contract during that year so that the bridges and heavy grading might be completed preparatory to the construction of the concrete pavement in 1945.

Work now in hand

Last year, the Division of Highways completed 43½ miles of new pavement on U. S. Highway 66, at a total cost of $4,060,000. In addition, about 20 miles were put under contract and will be completed this year. The total cost of this work will be about $1,750,000. The construction costs include all the heavy grading and bridge work involved in the several projects. All new construction on U. S. Highway 66 during the war as well as that being built now is portland-cement concrete pavement, 24 ft. wide and 10 in. thick.

Reconstruction of a two-lane pavement on the remainder of the badly worn pavement on U. S. Highway 66 will be undertaken as funds become available and as soon as right-of-way can be acquired. The final construction of the proposed four-lane highway will depend to a large extent upon traffic requirements and the availability of funds in view of the large

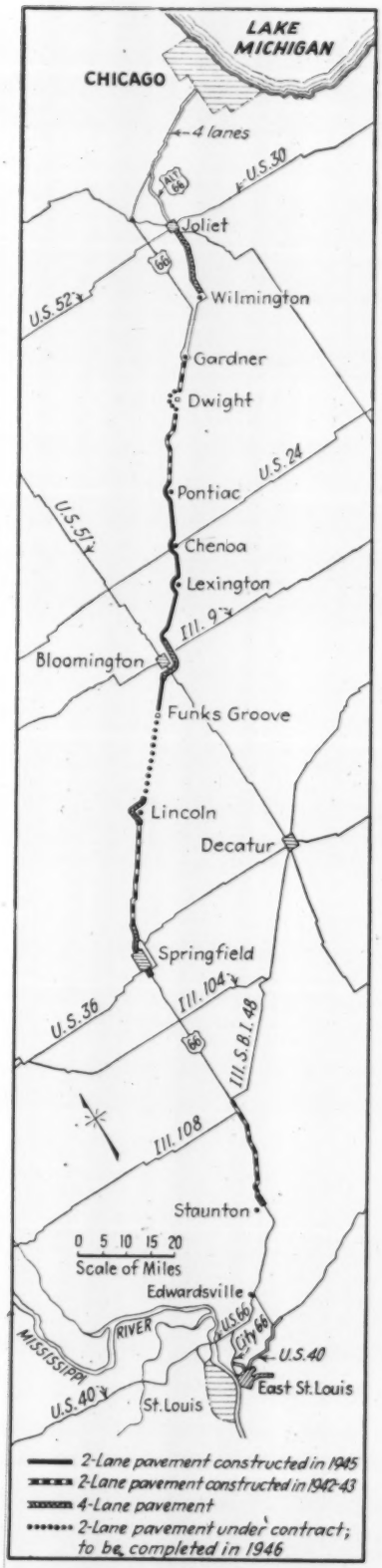


Fig. 3. Nearly 150 miles of new concrete pavement were built during the war on U. S. 66 in Illinois replacing pavement worn out under heavy truck traffic.

amount of mileage on the highway system which is in urgent need of replacement.

The entire length of U. S. Highway 66 between St. Louis and Chicago has been declared a "freeway" in accordance with a state legislative act adopted in 1943. By virtue of this act, the highway is designed principally for through traffic and owners of abutting property have no right or only a limited right of access by reason of the fact that their property abuts the highway.

Where new right-of-way is acquired it is not too difficult to negotiate with the adjoining land owner, either by purchasing his right of access or by providing parallel service roads leading to an established point of entrance to the highway. But where new right-of-way is not involved and the question is merely one of eliminating existing entrances to the highway built several years ago, considerable negotiations are necessary occasionally to appease the land owner so affected.

Separating medians

Several types of separating medians are used between the two parallel pavements, with the choice depending in a large measure upon whether the median is between an old and a new pavement, or between two newly constructed pavements. Other factors include topography, location and available width of right-of-way.

In some instances the median is only a 6-in. traffic stripe between the opposing double lanes of traffic. In others it may be a 4-ft. wide median built flush with the pavement surfaces or a 4-ft. barrier curb. Parkway medians also are used varying from 10 to 18 ft. wide. They are sodded and may be flush with the two pavements or have barrier curbs. The parkway median is preferred where right-of-way and topography permit.

Where right-of-way width permits, the separating median may be a sodded or seeded depressed parkway from 30 to 40 ft. wide. Right-of-way, which is furnished by the counties, is secured up to 200 ft. wide wherever possible.

Granular borrow subbase

It is a well known fact that pavement pumping is caused by a combination of three factors, (1) high-speed heavy truck traffic, (2) free water in the subgrade and (3) fine soil in the subgrade which will go into suspension

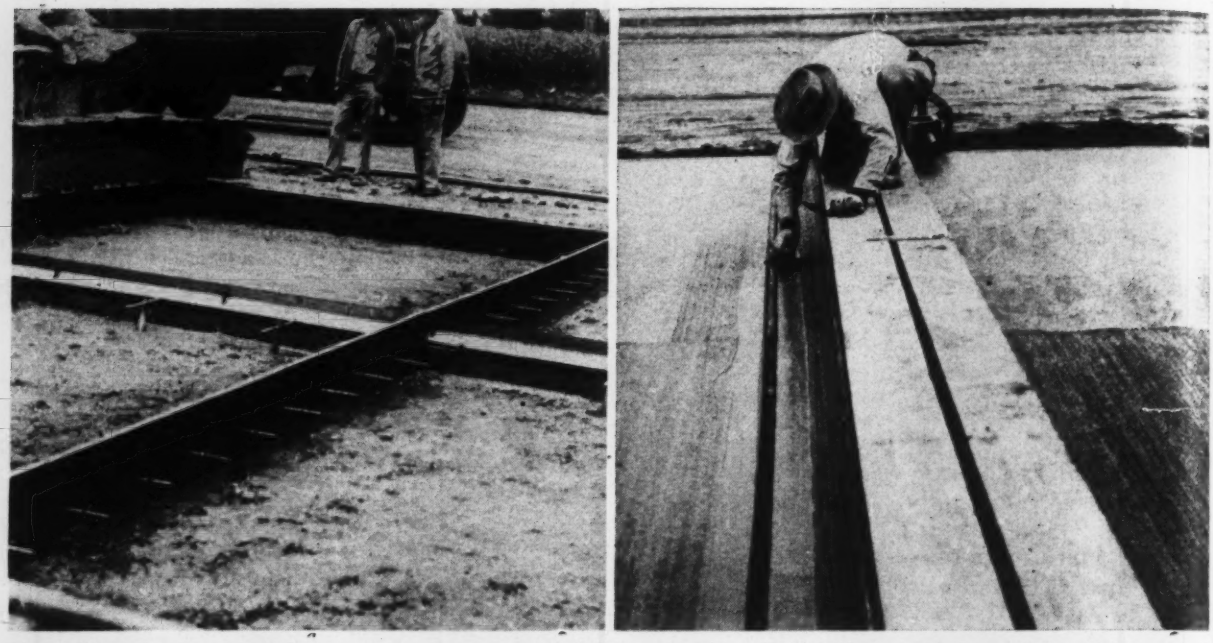


Fig. 4. Expansion joints with load-transfer devices at 100-ft. intervals and a plane of weakness at the centerline (left) control cracking in the pavement. Completion of the joint (right) includes removal of the U-shaped steel installing cap, hand troweling and filling the upper part of the joint opening with liquid asphalt.

during wet weather and be pumped out through joints in the slab. Furthermore, pavement pumping can be prevented by eliminating any one of these three contributing conditions.

Obviously, the first condition cannot be eliminated on a trunk line highway, and no one has been able to successfully eliminate free water in the subgrade. Thus, it becomes imperative that the third contributing cause of pavement pumping (fine soil which goes into suspension) be eliminated.

Compacted pervious base

Past experience has taught the Illinois highway engineers that the best way to prevent pumping of a concrete pavement is to install a layer of compacted gravel or crushed stone (granular borrow) directly beneath the pavement. Illinois has used a limited amount of granular borrow subbase for several years, but it now is being placed beneath virtually all new pavement on U. S. Highway 66 to insure long life for the concrete.

In general, the blanket of granular borrow is 6 in. thick, extending out 1 ft. each side of the 24-ft. pavement. It is placed on the compacted subgrade, just ahead of the new pavement, and thoroughly compacted to form a smooth dense surface.

Such large quantities of granular borrow are used (over 3,400 cu. yd., loose measurement, per mile of 24 ft. pavement) that its specifications were made as flexible as possible in the interest of economy. Specifications require all granular borrow to pass a 3-in. mesh. At least 45 percent must pass a No. 4 sieve, not more than 20 percent may pass a No. 50 sieve, while the clay and silt content may vary from 0 to 10 percent.

Most pit-run gravel deposits along the highway come within these specifications. Crushed stone also is used and, where economically justified, stretches of old abandoned pavement are broken up and crushed to proper size to make granular borrow. Unit prices for granular borrow, during the past four years have varied from $0.95 to $4.00 per cubic yard, installed in place on the highway; the wide variation in prices being due to cost of local materials as compared with commercially produced material.

Few drains needed

It can be seen from the foregoing specifications that almost any material that is sandy or gravelly makes satisfactory granular borrow. Moreover, past experience has proved that a dense graded, compacted granular material will not take up enough water to warrant the use of an extensive drainage system.

However, while it does not appear absolutely essential, lateral tile drains or bleeders are installed occasionally at low points in the grade line to drain the small accumulations of free water. If, however, the granular borrow is of an open gradation, lateral drains are provided more frequently to release the free water.

Expansion joints

No contraction or dummy joints are placed in the new pavement, but ¾-in. thick expansion joints are installed at 100-ft. intervals. In general, the expansion joint filler is a non-extruding, premolded fibrous asphalt material extending from 1 in. below the bottom of slab to within ½ in. of the top. The remainder of the joint is filled with a hot liquid asphalt flush with the top of pavement.

Live loads are transferred across the expansion joints by twenty-six ¾-in. smooth steel dowels, 18 in. long, placed 5 in. below the top of slab. One-half of each bar is greased to permit longitudinal expansion and contraction of the pavement. The lower edge of the bituminous filler rests 1 in. below the surface of the compacted granular subbase. The upper edge is held in straight alignment by an inverted U-shaped sheet-steel installing cap placed between the side forms.

After the concrete in the pavement has taken its initial set, the cap is removed and the top ½ in. of the joint

filled with liquid asphalt. Past experience in Illinois has demonstrated that this type of shear-transfer device effectively keys the adjoining slab sections together, causing them to act as a unit.

A longitudinal plane of weakness also is provided at the centerline of the pavement. It is a keyed joint formed with 18-ga. sheet steel extending from the bottom of slab to within ½ in. of the top and supported in place with tapered, 16-ga. steel channel pins. These pins, spaced about 3 ft. apart, are driven through the keyed portion of the longitudinal sheet steel into the subgrade.

The two halves of the pavement are tied together transversely with ⅝-in. deformed bars, 2 ft. 6 in. long, placed at the center of the slab and spaced 2½ ft. apart. They extend through the metal strip forming the longitudinal plane of weakness.

The concrete pavement is reinforced between expansion joints with welded wire reinforcement placed 2½ in. below the top of slab. Longitudinal wires in this fabric are No. 00 at 6-in. spacing, and transverse wires are No. 4 at 12 in. The welded wire fabric weighs 78 lb. per 100 sq. ft.

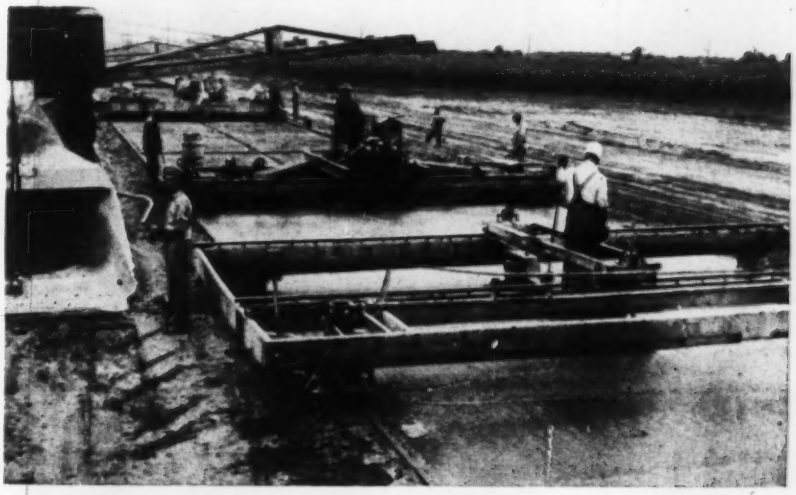
Center striping

All new concrete pavement on U. S. Highway 66 in Illinois contains an integral center stripe. It is a 4 in. wide stripe of black magnetic oxide of iron (ferroso-ferric-oxide) mixed into the concrete immediately following final brooming and prior to applying the curing compound.

The center stripe is installed by one man working from a light-weight steel-frame carriage that operates on four wheels along the top of the pavement side forms. In applying the stripe, two 3x3-in. by 8-ft. angles mounted 4 in. back to back beneath the carriage frame are pressed lightly into the fresh concrete on each side of the centerline of pavement.

The concrete between the angles is roughened by an ordinary garden scratcher or wood block with nails driven through it. A thin paste of water and the iron oxide is mixed into the top ¼ in. surface of the concrete, floated with a wooden float and finished with a steel trowel. The striping machine is hand propelled by a winch mounted on the frame. About 2 lb. of powdered iron oxide are required to install 100 lin. ft. of center stripe.

Due to wartime restrictions practi-



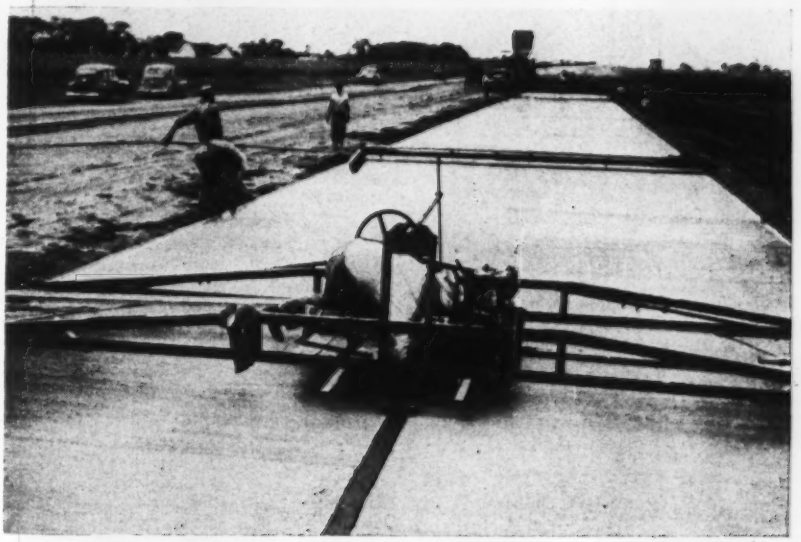


Fig. 5. After the fresh concrete is screeded and belted (top), it is hand-broomed and the center stripe is applied (center) following which it is sprayed with a curing compound (bottom).

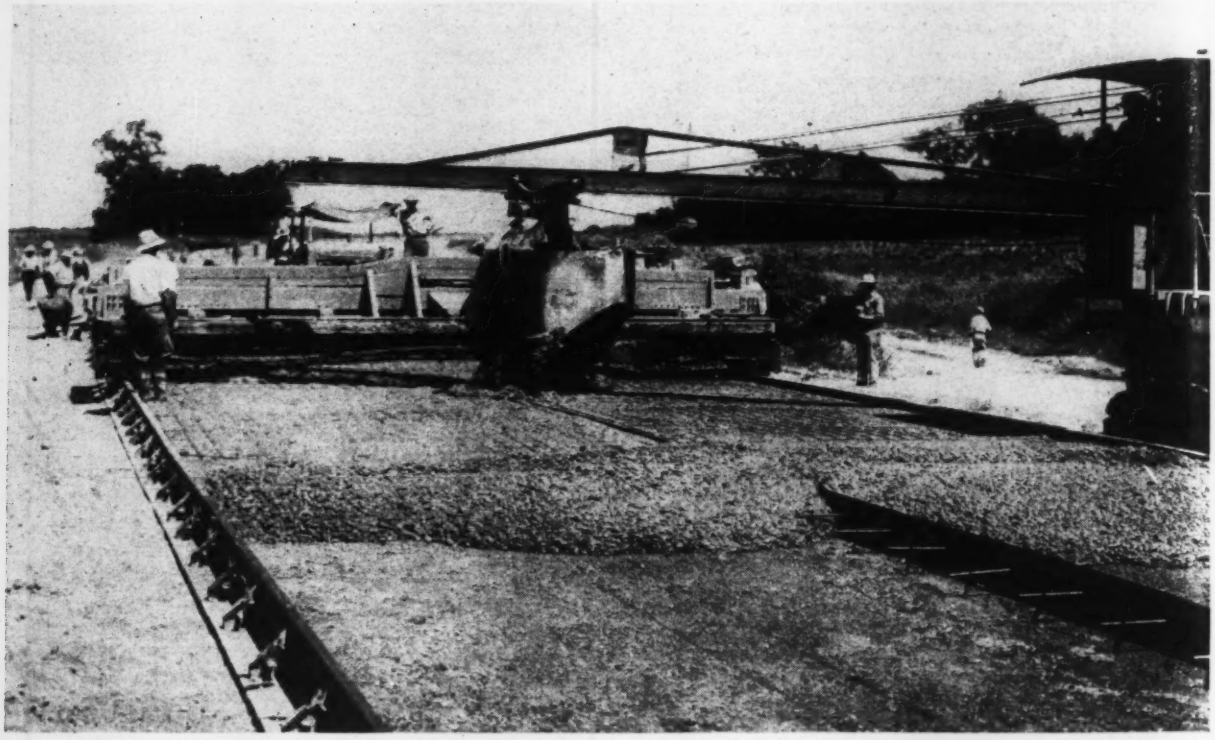


Fig. 6. Concrete is placed in two 12-ft. lanes simultaneously. All pavement is reinforced with wire fabric placed 2½ in. below the surface. Note the granular subbase in the foreground, which extend one foot beyond the pavement edge.

cally prohibiting the use of curing methods that are normally employed in Illinois, all pavement was cured by applying a membraneous curing compound to the fresh concrete. In general, two methods of application are currently used. One method employs a 35-gal. tank filled with the curing compound under a pressure of 55 psi. which operates transversely across the pavement on light metal channels atop of a 4-wheel steel frame carriage that rolls along the pavement side forms.

A hose from the tank feeds the curing compound to a 4½-ft. spray bar which moves back and forth with the tank. The spray bar has a light metal hood for protection from the wind. Following one complete passage of the spraying machine across the pavement, the supporting carriage is moved forward 4½ ft. by a hand operated windlass mounted on the carriage. Only one man is needed to operate the spraying machine.

The other method follows the same general principle of air pressure spraying from a carriage running on the side forms, but it has a spray bar extending completely across the pavement. Thus its direction of movement is parallel to the centerline of pavement.

The 1945 construction season got off to a poor start due to an unusually wet spring. But a relatively dry summer and fall permitted work to progress at a rapid pace. As can be seen from the acompanying table, large quantities of earthwork and granular borrow were required for each mile of pavement laid.

One enterprising contractor constructed up to 1,200 lin. ft. of 24-ft. pavement per day, using two 34E single drum pavers. The pavers worked along the highway in tandem, about 250 ft. apart. Mixing water was delivered to the site in three 1,500-gal. truck tanks and a 3-in. booster pump, operating between the two mixers, supplied them through two 150-ft. lengths of hose.

Concrete aggregates were delivered by dump truck from a batching plant, located nearby. The mix was proportioned in the ratio of 360 lb. of gravel, 220 lb. of sand, to 1 sack of cement. A water-cement ratio of 5.4 produced concrete having an average slump of 1½ in.

The welded wire reinforcement was pulled along on a sled behind the front paver and placed in position by two

TABLE I—CURRENT CONTRACTS AS OF OCT. 1, 1945

Contractor	Length of Project (Mi.)	Concrete Pavement (Sq. yd.)	Granular borrow (Cu. yd.)	Earthwork (Cu. yd.)
Arcole Midwest Corp., Chicago	7.7	108,700	46,800*	443,000
O'Connor Const. Co., Springfield, Ill	5.2	75,100	29,500*	192,400
J. C. O'Connor & Sons, Ft. Wayne, Ind	6.4	104,700	40,700*	450,000
I. D. Lain Co., Springfield	4.1	54,880	21,950*	280,600
Thos. McQueen Co., Chicago	7.9	121,670	31,900	427,000
White Consolidated Co., Chicago	14.3	202,950	67,850	446,000
Jansen-Schaefer Co., Pekin, Ill	1.8	.....	.....	296,000
Total	47.4	668,000	238,700	2,535,000

* Includes 6 in. of granular borrow over the entire 44-ft. shoulder width.

laborers. The supply was replenished with a small truck crane. No vibration or compaction was applied to the fresh concrete other than a small amount of internal vibration adjacent to the side forms and expansion joints. In some cases these vibrators were attached to the outer ends of the concrete spreaders and pulled along just ahead of the finisher. Final finish of the pavement was by a mechanical float followed by straight-edging, belting and hand brooming.

Traffic interference minimized

New construction is programmed so as to cause a minimum of inconvenience to the large volume of traffic now using the road. Where a future four-lane highway is contemplated the new slab usually is built parallel to the existing pavement and a short distance away.

Concrete slabs 7 in. thick and 22 ft. wide are built as cross-overs from each end of a completed length of new pavement to the existing pavement on either side of the job. When the intervening length of old pavement is to be discarded it is barricaded immediately in order to eliminate future maintenance.

As would be expected, many new bridges and drainage culverts are required for the new pavement. For spans up to 20 ft. the structures extend to the outside shoulders of the opposing highways. For longer spans, separate bridges of 28-ft. roadways are built to carry each of the separated highways.

Laboratory controls

The state highway laboratory located at Springfield, Ill. maintains close contact with all paving jobs to insure the quality of the work. All concrete is required to develop a compressive strength of 3,500 psi. and a tensile strength of 650 psi. at 14 days. Four 6x6x30-in. test beams are made daily on each concrete paving job. Each beam provides a tensile and a compressive test.

At the start of a job the laboratory determines the theoretical proportions of the concrete mix, depending on the type and quality of aggregates available. From this information the district engineer of materials sets up the mix on the job, which may be varied as necessary by the proportioning engineer.

State inspectors test the concrete aggregates at the source of supply, and cements usually are tested at the mills. After a job is completed, pavement thickness is checked by measuring cored specimens taken from the slab.

Anticipated traffic

For many years U. S. Highway 66 has been the most heavily traveled route in Illinois. Four lanes are urgently needed to carry present traffic on it at several locations now and its eventual improvement into a four-lane freeway from St. Louis to Chicago will be a race against time as the volume of traffic increases.

In 1941 the maximum total daily traffic count at three important points on the highway were: 9,500 just outside of Chicago; 4,000 at Springfield and 5,100 at Edwardsville, Ill., near St. Louis. Conservative estimates of the state highway research department place the 1950 peak daily traffic at 13,000 just outside of Chicago; 7,000 at Springfield and 7,500 at Edwardsville. Thus it can be seen that four lanes of pavement will be none too many to carry traffic rapidly and with safety.

Engineering personnel

All work on U. S. Highway 66 is being performed as regular federal-aid construction by the Illinois Division of Highways, Department of Public Works and Buildings, under the direction of Wesley W. Polk, chief highway engineer.

The engineering supervision is under the direct charge of Theodore Plack and Kendrick Havger, district engineers. Frederick M. Johnson, district engineer for Illinois, represents the PRA on all the work.

Fig. 7. Illustrating the degree of improvement is this new 24-ft. pavement which replaces an old 18-ft. slab of the early 1920's, shown at the right. The abandoned pavement will be broken up to make granular borrow for a future pavement of the four-lane highway.

Metropolitan Traffic Surveys Improved by Home-Interview Method

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Contents in Brief—*A new urban traffic-survey method based on systematic sampling of family units and home interviews provides more accurate information of travel habits and needs. A tested plan of survey procedure, worked out from surveys in 34 urban areas, has been developed by the Public Roads Administration in cooperation with the state highway departments and the Bureau of the Census and now is being applied to current planning.*

"WHERE DID YOU GO YESTERDAY?"—More than one-quarter of a million families residing in various metropolitan areas scattered throughout the eastern, southern, and midwestern states have been asked this question during the past eighteen months in connection with the acceleration of planning for highways into and through urban areas that followed the authorization of substantial expenditures of federal funds for highways in such areas.

The home-interview method of making metropolitan traffic studies is new. The first of such studies to be undertaken was in Tulsa, Okla. Subsequently, similar studies have been initiated in 37 other metropolitan areas involving 23 different states. Many of these areas comprise more than one city; for instance, the study now being made in the vicinity of Newark, New Jersey, involves 42 separately incorporated municipalities. In population, these communities range from 20,000 at Waycross, Ga., to Boston where 24 cities and almost two million people are included.

Better data needed

Comprehensive travel data are essential in developing a sound, long-range construction program. In urban areas, parallel streets offer many alternate routes of travel and people frequently go a considerable distance out of the way in order to use an attractive thoroughfare or to avoid one that is congested or otherwise unattractive; hence, the observation of traffic volumes and turning movements on existing thoroughfares without knowing where the vehicles started or where they are going does not provide sufficient information for planning expensive highway facilities. For this reason, information concerning the origin and destination of traffic and other related data obtained in home-interview studies are of paramount value to planning engineers.

Metropolitan area traffic studies, of the type being discussed, are divided into two parts: (1) the internal survey and (2) the external survey. The internal survey is further subdivided into three phases: (a) the home-interview phase, (b) the truck study, and (c) the taxi study. The internal survey provides information regarding travel which takes place entirely within the metropolitan area, generated by residents of the area and by trucks and taxis garaged within the area. The external survey provides information regarding travel which enters, leaves, or passes through the internal area, either by residents, non-residents, trucks, or taxis. The information from both phases can be combined in the analysis and the result will be a composite picture of all travel within the area on a typical day of the season in which the survey is conducted.

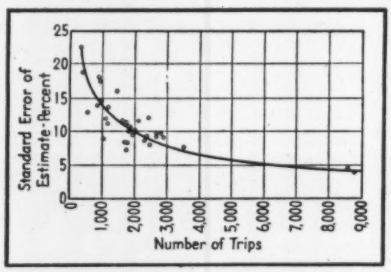

Fig. 1. Standard error of estimate for trip data obtained from interviews made at 10 percent of the dwellings in Savannah, Ga.

The technique for traffic studies by the home-interview method, as developed by the Public Roads Administration with the cooperation of the Bureau of the Census, is based upon the science of sampling which had been extensively employed in many fields of endeavor during the past several years.

It is not necessary to interview all residents of a city in order to determine their travel habits and their needs for traffic facilities. People living in any community have many similar travel habits for work, shopping, recreation, and other types of trips. If a representative sample is interviewed, the habits and needs of this sample will be indicative of those for all residents of the community. In order to be representative, a sample must be carefully distributed geographically throughout the entire community in the same proportion as the whole population is distributed.

Basis for sampling

In early discussions it was agreed that the best basis for sampling in the home-interview phase of the internal survey would be the dwelling, or single-family unit, similar to the dwelling unit specified by the Bureau of the Census. However, in several cities it was found impracticable to determine the number of dwelling units located at each address (other than apartments and large rooming houses) and, as a result, the "address" was used as the basis for sampling in these cities instead of the dwelling unit.

Sampling by addresses is easier and faster, but, where feasible, sampling by dwelling units is to be preferred because of the better geographical distribution attained. Satisfactory results

have been obtained by both procedures.

The proportion of dwelling units selected for interview has varied in different studies. In fact, different sample ratios have been used within the same study. For general purposes, the following table may be used as a guide in determining the size of the sample needed:

Population of area	Size of sample percent
Under 50,000	20
50,000 to 300,000	10
300,000 to 1,000,000	5
Over 1,000,000	4

Shown graphically in Fig. 1 is the results of a mathematical check applied to the trip data to test the adequacy of the sample in Savannah, Ga., where a 10-percent sample was used. From this curve it is evident that the standard error for a group of 6,000 trips is only 5 percent, whereas for a group of 1,000 trips it is 14 percent.

Selecting the sample

Bureau of the Census block statistic records, prepared in pamphlet form for all cities of 50,000 population and over, are found very useful in maintaining a logical sequence in sample selection, in recording progress of the work, and in checking the number of dwellings counted in each block.

Samplers working in pairs have been found most efficient. One member of the crew does the counting and makes the selections while the other member records the addresses. As many crews of two as desired may be put to work, each working in a different census tract.

Various records have been discovered in different cities and used for making the sample selection. The most popular and perhaps the best basis for making the selection is the so-called Sanborn map when used in conjunction with either a city directory or a land-use map, or preferably both.

A section of a Sanborn map with the dwelling units marked which were selected for the sample is shown in Fig. 2. In this case the sample is 10 percent and the person making the selection counts around each block in a clockwise direction, indicating every tenth dwelling for inclusion in the sample. Any extra units that may occur at the end of the census tract are dropped and counting starts anew at the beginning of the next tract.

This particular map contains mainly one-family dwellings. In case of an apartment house, the map does not show the number of apartments and this information must be obtained from a city directory, through a telephone call, or by ground inspection. After the number is ascertained, each apartment is treated as though it were a one-family dwelling, and counting proceeds through the apartment house, every tenth apartment being designated for inclusion in the sample. Dwellings over stores, and rooms occupied by permanent residents of hotels are counted in selecting the sample.

Locate cordon line early

The external cordon, a hypothetical line delimiting the area to be included in the internal survey, is located soon after the start of the sample selection. As a guide in determining the proper location it must be recognized that home interviews are to be made in all parts of the area included inside the cordon and that external interview stations are to be operated on all important roads at points where they cross the cordon line.

At least three conditions should be met in establishing the location: First, thickly populated suburban sections should be included by the cordon; second, the line should not extend through a network of streets or roads as this would necessitate too many external interview stations; and third, it should intersect all roads at a point suitable to operate an interview station.

Ordinarily the cordon line is located far enough out to intersect a minimum number of roads and still not include strictly rural territory in the internal survey.

Another early consideration is the subdividing of internal and nearby external areas into small segments for use as origin and destination zones. Census tracts were originally used as origin-destination zones, but in many cases were found unsuitable because of size or shape, and required subdivision anyway; hence, the present policy was adopted of creating new origin and destination zones regardless of census tract lines.

The manner in which the area is

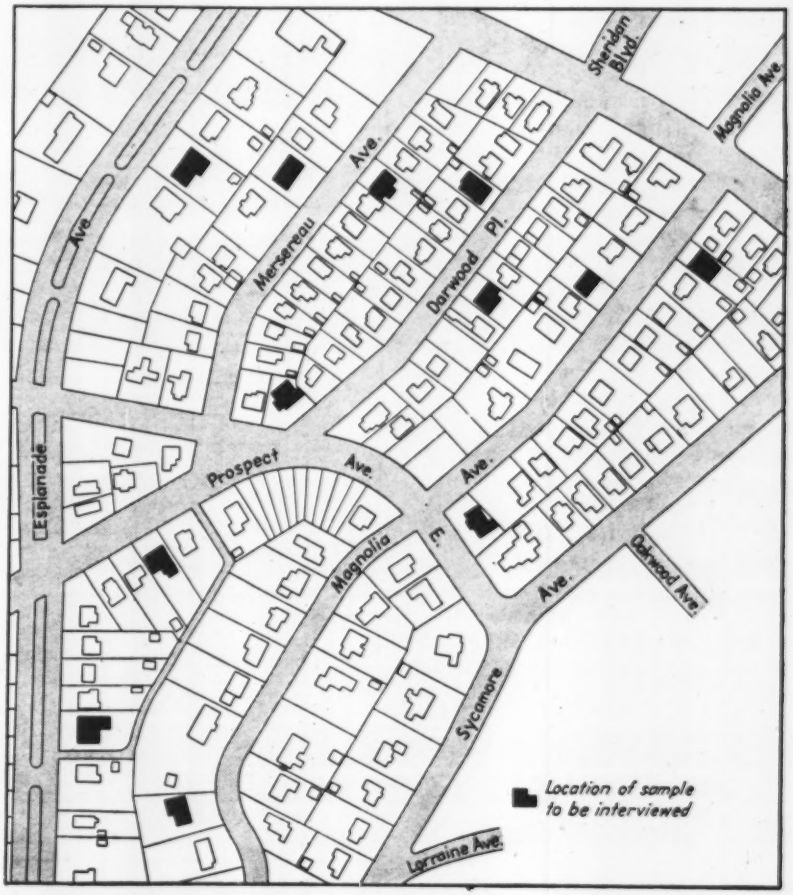

Fig. 2. Best basis of sample selection for home-interview survey is a Sanborn map; solid black shows the dwellings selected in a 10 percent sample survey.

zoned becomes extremely important in the analysis, and therefore, the zoning should be done by someone completely familiar with the area. The primary consideration in zoning is land use. Large factories, principal office buildings, main railroad stations, and even large department stores may each constitute a separate zone.

In general, the zones should be of small size in the downtown business section, possibly comprising one or two city blocks, and gradually increase in size until each zone in the outlying residential districts may include 20 to 40 city blocks. A special numbering system can be designed so that zones adjacent to each other, and possessing similar characteristics, can be grouped together by machine accounting methods and studied as larger units in the initial analysis. It is important, however, to be able to study the survey data in terms of the smaller zones when specific highway locations are to be analyzed.

Well-trained interviewers necessary

The quality of personnel engaged to make interviews has a decided influence upon the outcome of the entire study. The interviewer is the one who talks with people whose traffic needs are to be determined and who gives to the public the only first-hand information about the survey, thus determining, to a great extent, whether response is free and cooperative, or suspicious and grudging.

Dwelling unit interviews

Each dwelling selected in the sample is visited and pertinent data obtained for each member of the family. In all surveys made to date, travel information has been obtained for weekdays only, Monday through Friday, because week-end travel was extremely curtailed by wartime restrictions. Interviews are conducted Tuesday through Saturday, permitting inquiries to be made about travel "yesterday." With this procedure the respondent is able to recall the desired information with less difficulty and greater accuracy.

Arrangements to record Saturday and Sunday travel probably will be made in future surveys.

Trucks and taxi movements are ignored in the home interviews although trips made by passengers in each are recorded. Travel by automobile, bus, or streetcar is recorded, and local travel by train or boat is included in cities where appropriate. All travel by any means of transportation is recorded except by motorcycle, bicycle, or walking.

Every effort is made to obtain complete information concerning all travel by all residents in a sample dwelling and the interviewer is instructed to make as many calls as are necessary to accomplish this. The original practice was to accept information from one member of the family regarding travel of other members. Interviewers now endeavor to question the person actually making the trip, especially automobile drivers.

Favorable publicity in newspapers and by radio, explaining the purpose and methods of the survey before interviewing is started, has been helpful in obtaining public cooperation. To inform residents of each sample dwelling about the study, postcards or letters inviting cooperation and giving in-

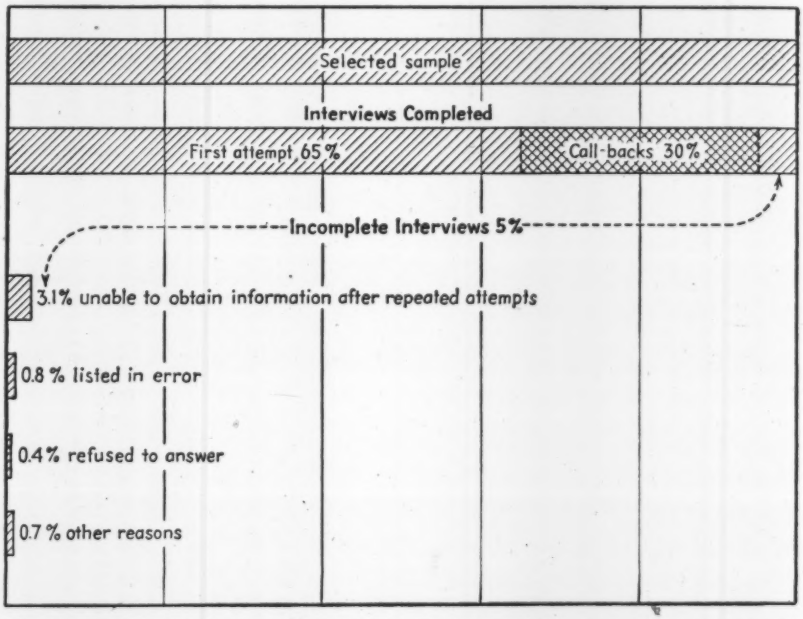

Fig. 3. Combined data from three cities show remarkably complete coverage of sample dwelling units obtained by interviewers.

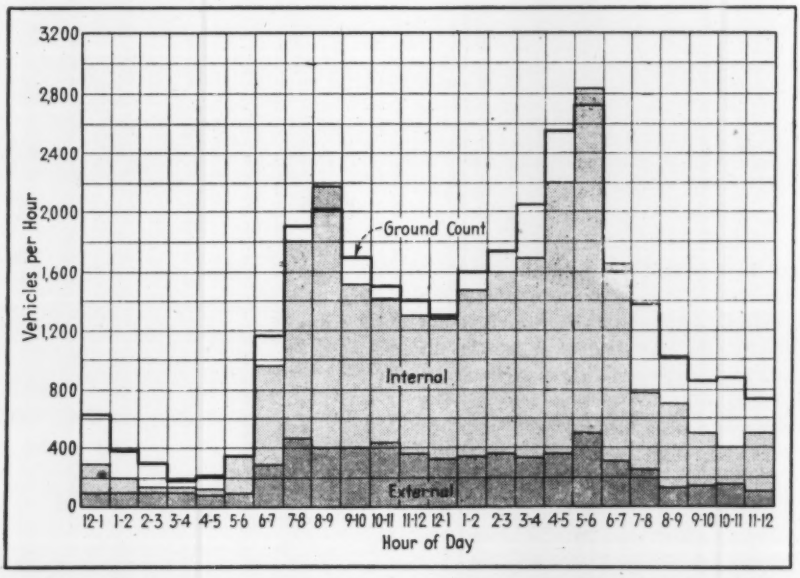

Fig. 4. Comparison of the actual number of passenger cars and trucks counted at three central points in Milwaukee with the number estimated from interviews to have passed those points.

formation concerning the study are mailed to the sample address a few days before the call is to be made. With such aids the public reception has been excellent.

Fig. 3, which gives combined data from Tulsa, Nashville, and Savannah, shows that the number of persons refusing to answer has been negligible, amounting to only 0.4 percent. It shows further that in 65 percent of the cases complete information was obtained with one call and that in 30 percent, repeat calls were necessary. Interviews can usually be obtained at the rate of about one per hour, including repeat calls and time used in going from one sample dwelling to the next.

Pertinent data obtained

Interview forms that are similar in character have been used in practically every survey, although each form has been varied to best fit existing conditions and to utilize experience gained in previous surveys.

The principal information recorded on the interview questionnaire is:

For each dwelling unit—
- Number of automobiles owned
- Number of automobiles in usable condition
- Total number of persons
- Sex, race, occupation, and industry of each person

For each trip—
- Day of travel
- Origin and destination
- Time of starting and arrival
- Mode of travel
- Purpose of trip
- Prewar mode of travel

In addition, for automobile driver trips—
- Number of occupants in car
- Whether trip was direct or indirect
- Number of intermediate stops
- Purpose and location of intermediate stops
- Control points passed
- Location, kind, and cost of parking

With the above information, traffic analysts can reproduce present travel within the internal area by any mode of transportation, showing desired lines of travel, together with volumes of traffic by hourly periods. Not only can existing traffic be reproduced, but also, by utilizing occupation, industry, trip purpose, and prewar mode of travel, changes due to reconversion and the anticipated shift from public carriers back to private automobiles may be taken into consideration and reliable estimates made of future traffic.

Separate factors for expanding the sample dwelling-unit information are computed for each census tract (or predetermined zone if the area is not subdivided into census tracts) by dividing the total number of dwelling units counted in the tract by the total number of samples from which information is received. Expansion factors are usually equal to the sample ratio, or nearly so, unless some of the selected families refuse to give the information requested.

Fig. 5. Traffic being interviewed at an external interview station near Lincoln, Neb. Only a random sampling is taken, the number interviewed during any period depending on the volume of traffic.

Expansion separately by each tract permits average data for dwellings of close geographical location and probable similar characteristics to be applied to dwellings where information could not be obtained, instead of applying to these dwellings average data for the entire internal area. Expansion of each tract separately also permits the "carry-over" or number of dwellings remaining after the last sample is selected in the tract, to be taken into consideration.

The following formula is recommended for use in computing the expansion factor for each tract:

$$\text{Factor} = \frac{A - \left(D \times \frac{A}{B}\right)}{B - (C + D)}$$

Where: A = Total dwellings counted in tract
B = Total sample dwellings selected
C = Sample dwellings—no information obtained
D = Sample dwellings—vacant

The basis of sampling for trucks and taxis is the motor vehicle registration records. A 20-percent sample has been used in almost every survey undertaken. Every fifth truck registered in the internal area is included in the sample by recording the license number and the owner's address. Interviewers then call on the owner of each truck selected and obtain information concerning all trips made by that specific truck on the day preceding the interview.

Data recorded for truck trips consist of origin, destination, time of trip, a list of stops made, commodity carried, and control points passed.

Taxi use is surveyed in the same manner as truck use, although the size of the sample is frequently increased if the number operating in the internal area is relatively small; in fact, trip data for all taxis operating in the area are sometimes obtained in such instances. The desired information is often available from manifest records maintained by the taxi company, and personal interview of the drivers is unnecessary.

Expansion of the truck and taxi samples is made in a manner similar to the dwelling unit expansion with the exception that the total number of trucks or taxis registered in the internal area are used instead of the number of dwelling units.

The external survey data are obtained by establishing roadside interview stations on all important roads at a point where each road crosses the cordon line, and interviewing a random sample of the vehicles entering and

leaving the internal area. Each station is operated for one weekday between the hours of 6:00 a.m. and 10:00 p.m. In addition, interviews are made between 10:00 p.m. and 6:00 a.m. at a few of the more important stations where a large amount of night travel is known to exist.

No attempt is made to select for interview a definite, predetermined proportion of the vehicles passing each station. The number of interviews obtained depends entirely upon the number of interviewers assigned to the station and the number of vehicles passing. The recommended policy is to assign sufficient personnel to each station to interview approximately 50 percent of the traffic passing during peak hours. During the remaining hours of operation the crew will, of course, be able to interview a greater percentage of the vehicles passing the station. Each interviewer can average from 30 to 40 interviews per hour.

A simple questionnaire form is used for the external survey in order to minimize delay to the vehicle driver. Much of the information, such as time of day trip was made, type of vehicle, number of passengers, direction of travel, etc., can be recorded by observation as the vehicle approaches. The origin, destination, purpose of trip, location and purpose of intermediate stops, and control points passed are practically the only direct questions that need to be asked. One minute is the average time required to complete an external interview.

Motorists will go out of their way to use a traffic facility over which they can travel freely, hence observations of traffic volume do not give as true a picture of actual needs as is given by the home-interview method of traffic study.

During the interview period all traffic passing the station in each direction is counted, classified by type, and hourly totals recorded for use in expansion. Expansion factors are computed separately for each hour and for each classification by dividing the total number of vehicles passing in each hourly group by the number of interviews obtained in that group.

Personnel required

The personnel needed to conduct a metropolitan traffic study by the home-interview method depends primarily upon the number of sample dwellings selected for interview and the length of time over which the work is to extend. The size of the city does not necessarily govern the number of persons required. For instance, a medium-size city using a 10-percent sample and electing to complete the work in a short time might require more people than a much larger city using a 5-percent sample and extending the work over several months' time.

A quick, easy method of estimating the total number of man-hours required to complete a metropolitan study by the home-interview method is to determine the total number of sample dwellings to be interviewed and allow 5 man-hours for each sample. The number of samples for any area may be approximated by dividing the total population of the area by 3½ times the number of dwellings represented by one sample.

The total cost may be estimated by multiplying the number of samples by $6. All phases of the study are included in the above unit figures.

Results obtained from completed metropolitan traffic studies are proving most conclusively that circumferential, or bypass routes will not greatly relieve traffic congestion in larger cities. Information collected in external surveys indicates that in cities of 50,000 population or greater, 87 percent or more of all vehicles crossing the external cordon line have origin or destination within the urban area and, hence, would not use a bypass route. Free-flowing arterial routes extending into and through large cities are needed for greater traffic service and, to accomplish this, the necessity for close cooperation of city, county, state, and federal authorities in the coming highway construction program cannot be over-emphasized.

Milwaukee's Street Inventory Record

Raleigh W. Gamble
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Milwaukee, Wis.

***Contents in Brief**—Accurate predictions of future pavement requirements and reconstruction of streets in Milwaukee, Wis., will be simplified by a comprehensive card inventory system being prepared on a city-wide basis. Based on a newly developed "block and intersection method" of survey and analysis, the street inventory records are assembled into a visible file for instant accessibility. Duplicate information is coded and punched on tabulating machine cards.*

As an aid to better programming and planning its street construction and maintenance, Milwaukee has developed a simplified and systematic method of inventorying its present street system. When the currently operating survey is completed, the city will have assembled into a single record a visible card inventory of its streets together with a tabulating card duplicate of the same information.

The completed card inventory will provide a single, readily accessible source of information to replace the present widely scattered original sources. This inventory record also will be of material assistance in making detailed studies of existing problems, preparing future paving and maintenance programs, and compiling data. With the completion of the pavement life analyses, it will be possible to accurately predict future paving requirements in order to provide a financial program over a reasonable term of years.

Data coded on punch cards

In November, 1944, the city of Milwaukee, in cooperation with the Public Roads Administration, began assembling from numerous sources detailed data pertaining to construction features for existing streets and historical data relating to past construction and retirement experience. While the various states and the PRA have conducted similar studies under the State-Wide Highway Planning Surveys, it has not been general practice heretofore for the Public Roads Administration to participate in similar municipal studies.

While the present discussion will be limited to the problems arising in the preparation of the street inventory features of the project, the data so gathered is being coded and placed on punch cards for use in tabulating machines. Many of the methods and procedures adopted for the selection and gathering of information were influenced by this requirement.

A major problem that had to be solved was the selection of a method to divide the entire street system of approximately 824 miles into small, usable, basic units. The "block and intersection method," in which each block and each intersection constitutes a unit, was adopted as most suitable. While this method solved many difficulties it also created additional problems, the solutions of which are believed to be new in concept and scope.

Also taken into consideration, but subsequently discarded as unworkable, were (1) the construction contract method of inventory, which determines the length of the unit by the limits of the project as described in the contract, and (2) the fixed limits method, which uses predetermined fixed points such as ward boundaries, topographical features, a system of arterial streets, or other preselected points, to determine the length of the unit.

For the purpose of the study, a "street" is the entire right-of-way between the property or lot lines dedicated to public travel and includes the pavement, walk, curb and gutter and accessory structures (Fig. 1). An "intersection," by our usage, is that section of a street lying between property lines formed by two or more intersecting streets, while a "block" is that section of a street lying between intersections.

Streets and intersections

The block and intersection method was adopted for the following reasons:

1. Established blocks and intersections are relatively fixed and unchangeable after a subdivision has been platted and accepted. This characteristic readily lends itself to the use of the block and intersection as the basic unit

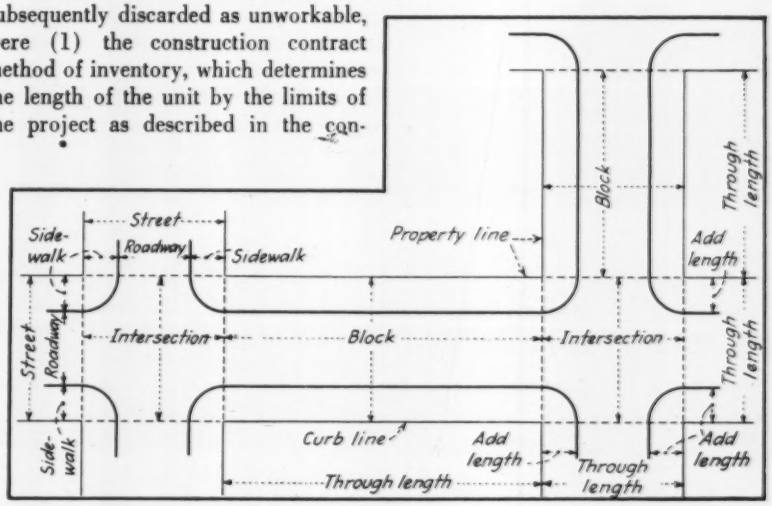


Fig. 1. All streets are divided into two basic units; the "block" and the "intersection." Street width extends to the property lines, with the length of each block extending between intersections.

upon which to build a history of all past, present and future construction work. Each paving contract can be subdivided into the basic units whether it provides for improvements in one block, a series of blocks and intersections, or portions of a block or intersection.

Furthermore, our experience indicates some individual blocks with as many as six different pavements laid over the past 84 years for which records are available. No difficulties were encountered in compiling the data for the single block because its limits remained unchanged over this period. It is evident that the construction contract length with its ever-changing limits for successive contracts on any one street would not be adaptable as a basic unit.

2. Changes in basic data, such as type of curb and gutter, type of pavement, widths, etc., often take place from block to block and demand special treatment and description which can be rendered rather simply under the block and intersection method. By comparison, the descriptive explanation of variations from the average over a multiple block unit would become more difficult and complex.

3. Data is assembled for all streets which are platted, even though they have not been paved. With the block and intersection method, this can be done by subdividing the street into its individual blocks and intersections, but, with the contract method, no definite basic unit would be available until an improvement is made and the contract length established.

4. The card filing system has an established uniformity. When entering the visible filing record, it is known that each card will cover only one block or one intersection and that they are filed in the same sequence that exists in the field. This regularity is not available with other basic units.

Five classes of intersections

In the application of the block and intersection method to the breakdown of a selected street into its component blocks and intersections, the problems produced at intersections are the most troublesome. For our purpose, all intersections are divided into the following general groups as indicated in Fig. 2:

Standard intersection (A), two streets intersecting at a common point and both extending beyond the common intersection formed. Dead end (B), two streets intersecting at a common point but only one extending beyond the common intersection formed. Offset (C), two streets not intersecting at a common point but with both extending beyond the two intersections formed. Multiple intersection (D), three or more streets intersecting to form a common intersection; and special or miscellaneous intersections which do not conform to any of the previously explained groups.

After having classified the intersections, the block is the remainder between intersections. Various forms of these are indicated (E) in Fig. 2. The basic block and intersections units thus formed are the basis upon which the card record is prepared. One card is used for each block and two or more cards for each intersection, depending upon the number of streets involved in the intersection.

Originally, it was considered sufficient to have only one card for a standard intersection formed by an east and west street and a north and south street. However, if this card was then filed with the east and west street, it would leave the north and south street record incomplete. As information is required for intersections on all streets, it is essential to prepare an intersection card for each of the streets involved.

Using Fig. 2 as an illustration, intersections are described as N. 19th Pl. at W. Lincoln Ave., or W. Lincoln Ave. at N. 19th Pl., depending upon the street with which the intersection is being taken. The names of all intersecting streets are used in the description. For example, one description of a multiple intersection would be given as W. Abert Pl. at N. 19th St.—W. Washington Ave.

To distinguish between the two intersections formed by an offset intersection, one is described as W. Abert Pl. at N. 18th St. (East) and the other as W. Abert Pl. at N. 18th St. (West). Partial intersections are shown as N.½ W. Abert Pl. at N. 20th St., or W. Abert Pl. at N. 19th Pl., except SW¼.

As a sketch is not included on the final card, the description of the limits of a block must present a word picture of the existing conditions. The usual block between two intersections would be described as W. Lincoln Ave. from N. Adams St. to N. 19th Pl. However, the description W. Abert Pl. from N. 18th St. (West) to N. 19th St.—W. Washington Ave. would immediately register as a block with an offset inter-

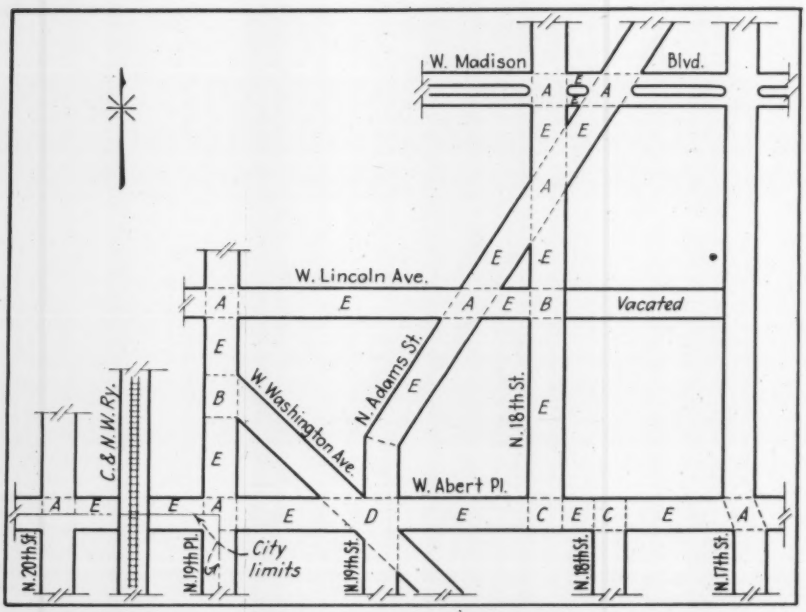
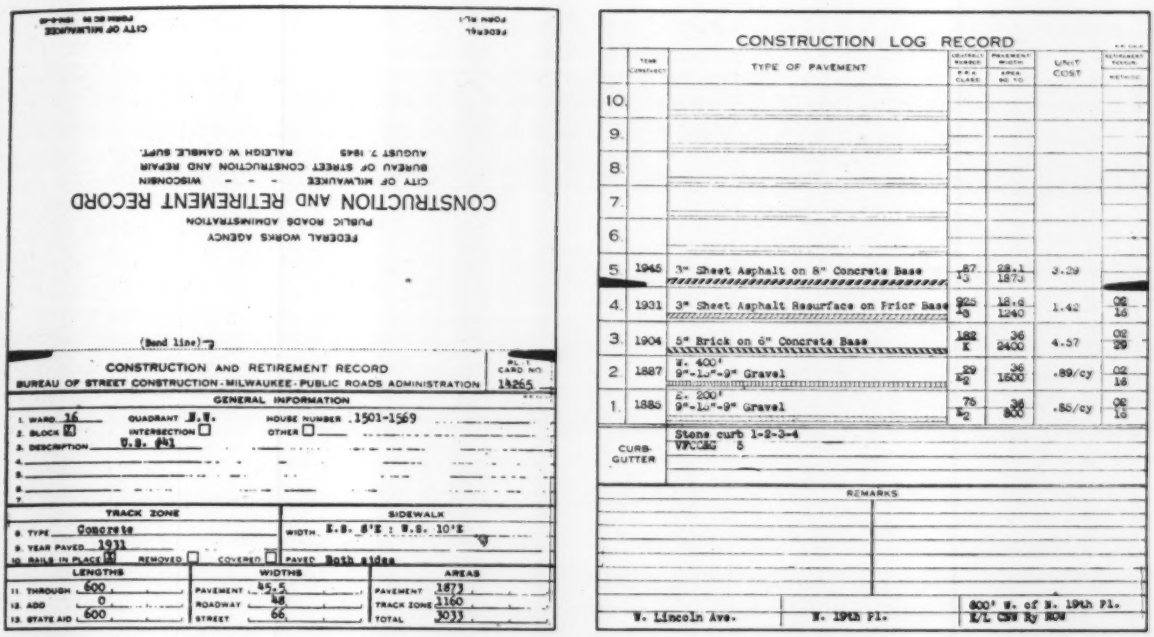


Fig. 2. Intersections are classified in five different categories, A, B, C, etc., while block classifications include all definite breaks in the street proper such as bridges, viaducts and railroad grade crossings.



CONSTRUCTION AND RETIREMENT RECORD
BUREAU OF STREET CONSTRUCTION - MILWAUKEE - PUBLIC ROADS ADMINISTRATION

GENERAL INFORMATION

1. WARD 16 QUADRANT N.W. HOUSE NUMBER 1501-1569
2. BLOCK 4 INTERSECTION ☐ OTHER ☐
3. DESCRIPTION W.S. 8th

TRACK ZONE
8. TYPE Concrete
9. YEAR PAVED 1931
10. RAILS IN PLACE ☒ REMOVED ☐ COVERED ☐ PAVED Both sides

SIDEWALK
WIDTH E.S. 8'E ; W.S. 10'E

	LENGTHS	WIDTHS	AREAS
11. THROUGH	600	PAVEMENT 45.5	PAVEMENT 1873
12. ADD	0	ROADWAY 48	TRACK ZONE 1160
13. STATE AID	600	STREET 66	TOTAL 3033

CONSTRUCTION LOG RECORD

	YEAR CONSTRUCT	TYPE OF PAVEMENT	CONTROL NUMBER AREA CLASS	PAVEMENT WIDTH AREA SQ. YD.	UNIT COST	RETIREMENT REASON METHOD
10.						
9.						
8.						
7.						
6.						
5.	1945	3" Sheet Asphalt on 8" Concrete Base	87 / 13	28.1 / 1873	3.29	
4.	1931	3" Sheet Asphalt Resurface on Prior Base	905 / 43	18.6 / 1240	1.42	02 / 16
3.	1904	5" Brick on 6" Concrete Base	182 / K	36 / 2400	4.57	02 / 29
2.	1887	W. 400' 9"-Lo"-9" Gravel	29 / ½	36 / 1600	.89/cy	02 / 16
1.	1885	E. 200' 9"-Lo"-9" Gravel	76 / ½	36 / 800	.86/cy	02 / 16
CURB-GUTTER		Stone curb 1-2-3-4 WPCCBC 8				

REMARKS

W. Lincoln Ave. | N. 19th Pl. | 800' E. of N. 19th Pl. E/L CNW Ry ROW

Fig. 3. Reference data and general information for each block are entered on the front side of the "Construction and Retirement Record" card (left) while a log of the construction record appears on the back (right). The narrow band beneath each type of improvement is colored (as indicated here by shading) to give quick visual record of the type of surface.

section at one end and a multiple intersection at the other.

All railroad grade crossings, bridges, viaducts, or similar construction which form a definite break in the street are considered as a block and described as such. These structures, along with other block limiting features such as city limits, parks, etc., must be located definitely with respect to the intersections and described as N½W. Abert Pl. from N. 19th Pl. to E/L CNW Ry. —152 ft. W. of N. 19th Pl. The railroad right-of-way would be described as N½ W. Abert Pl. from E/L CNW Ry. to W/L CNW Ry. and the following block would be N½ W. Abert Pl. from W/L CNW Ry.—184 ft. E. of N. 20th St., to N. 20th St.

The preceding description, in which only the N½ of W. Abert Pl. is mentioned, is also characteristic of those prepared when a street serves as a boundary between two municipalities or is only partially open for street purposes. In these instances the description should include only that portion of the street dedicated to public travel within the city.

As a boulevard is considered a divided-lane street in which traffic moves in one direction only on each pavement strip, it is best to describe each strip in a manner similar to W. Madison Blvd. (N.Road) from N. Adams St. to N. 18th St., and W. Madison Blvd. (S.Road) from N. Adams St. to N. 18th St.

In the process of preparing the basic block units, many blocks were found to be vacated, closed, used as a park or playground, or not open for some other reason. It was thought advisable to prepare and include a block card and insert a description of the reason for closure rather than lose this information which was confirmed after a lengthy search. Any future questions regarding the block can be answered without another search.

Permanent card record file

In its final form, the information for individual blocks and intersections will be inserted on the "Construction and Retirement Record" card (Fig. 3) which is an 8-in. x 9-in. form that is slotted, indexed and folded for use in the conventional 5-in. x 9-in. visible file cabinets. A total of approximately 25,000 individual cards comprise the entire file, or approximately 30 per mile of platted streets in Milwaukee. A two-color card system, with white for intersections and buff for blocks, is used to provide a visible distinction when both types of cards are filed in the cabinets.

The construction and retirement record card is designed with three general sections of information: (1) Reference data, including general information, track zone, sidewalk, lengths, widths, areas, (2) Construction log record, including specific data relating to both pavement and curb and gutter construction, (3) Remarks, including explanatory data not applicable to previous sections.

A description of the general features of this card will serve to illustrate the purpose to be served and the problems involved in the selection and arrangement of basic information. In most instances, the information required is not difficult to obtain as it is available in various previously prepared records. A lead to available data could be traced to its original source and the information then gathered, sorted and consolidated into usable form.

As an illustration, it can be stated that 20 original sources had to be probed for information relating to pavement construction. These included ten sources of material in city departments; seven in outside municipal, county and state agencies to obtain data on streets paved before they were annexed to the city; and three with private contractors and real estate op-

erators for records of subdivision improvements built privately. This gives some conception of the value to be derived from having all this information in a single file.

All reference data has been consolidated to appear on the first page, or flap, of the record card (Fig. 3, lower left) so that when entering the file for information relating to a specific block, this most generally required information is more accessible. On line 1 under "General Information" are inserted the ward number, quadrant and house number for the block or intersection in question.

The ward number is obtained directly from a map on which the ward boundaries are indicated. No problems arise except when a street is the boundary between two wards. As the ward line is established along the center line of the street in such instances, the boundary blocks and intersections are assigned arbitrarily to the ward to the south or west. It was felt that studies may be required on some unit smaller than the city-wide basis and the 27 wards with their established boundaries provide the desired subdivision.

City divided into four quadrants

For the same reason, it was thought advisable to divide the city into four quadrants as fixed by the established base lines which control the house number and street name system. The quadrant information NE, NW, SW, SE, is obtained directly from the abovementioned ward map on which the base lines also are shown. Boundary blocks and intersections are assigned to the quadrant to the south or west.

House numbers are included on the card as a means of identifying the block or intersection when that is the only information available. House numbers begin at the established east-west and north-south base lines with "100" and increase progressively at the rate of 100 numbers to the block in all directions to the city limits. Whenever possible, a number is assigned to each 15 ft. of property frontage with even numbers on the north and east sides of the street and odd numbers on the south and west sides.

Generally, the house number assigned to intersections is an even "100", as 2900 or 3000, whereas the block is given a span of numbers from the lowest to the highest within the block, as 2901 to 2965. This information is taken from atlas books which had been prepared previously and maintained up to date to show the specific house number assigned to each platted lot in the city.

On Line 2 of the first page of the record card (Fig. 3, lower left) the type of unit is checked as "Block," "Intersection," or "Other," which includes grade crossings, bridges, viaducts, or other special units. At present, the "Description" on Line 3 is being used to indicate the route number of the state trunk or federal highway system of which the block or intersection is a part. However, it could be extended to include any distinguishing features desired.

The track zone, usually double track with a standard 17.1 ft. width, is not considered a part of the pavement area as it is maintained by the local transport company. It need not necessarily be constructed or reconstructed at the same time nor with the same pavement type as that portion of the roadway between track zone and curb. Basic data, such as pavement type, year paved, and status of rails, must be gathered separately. Intersection cards will carry directional information, N-S, E-NW, S-NE, after pavement type to indicate the position of the track zone in the intersection. All information is obtained from a combined visual field inspection and transport company records.

Sidewalk area

The sidewalk area is considered that section of a street between roadway and property line reserved especially for the use of pedestrians. Legally, all sidewalk widths are established by Common Council ordinance, but the width must be assumed where it has not been established in undeveloped areas. To cover these variable conditions, "established" walk widths are designated as 15′*E* and "assumed" widths as 15′*A*. A further distinction is made if the sidewalk widths are not the same for both sides of the street.

As an example, the width on the north side of the street may be established at 15 ft. (N.S. 15′E) and the south side assumed at 12 ft. (S.S. 12′A). If both sides are not paved, a lineal measurement will be inserted after the item "Paved" to indicate the portion of the block which has paved walks, as N. 240 ft.

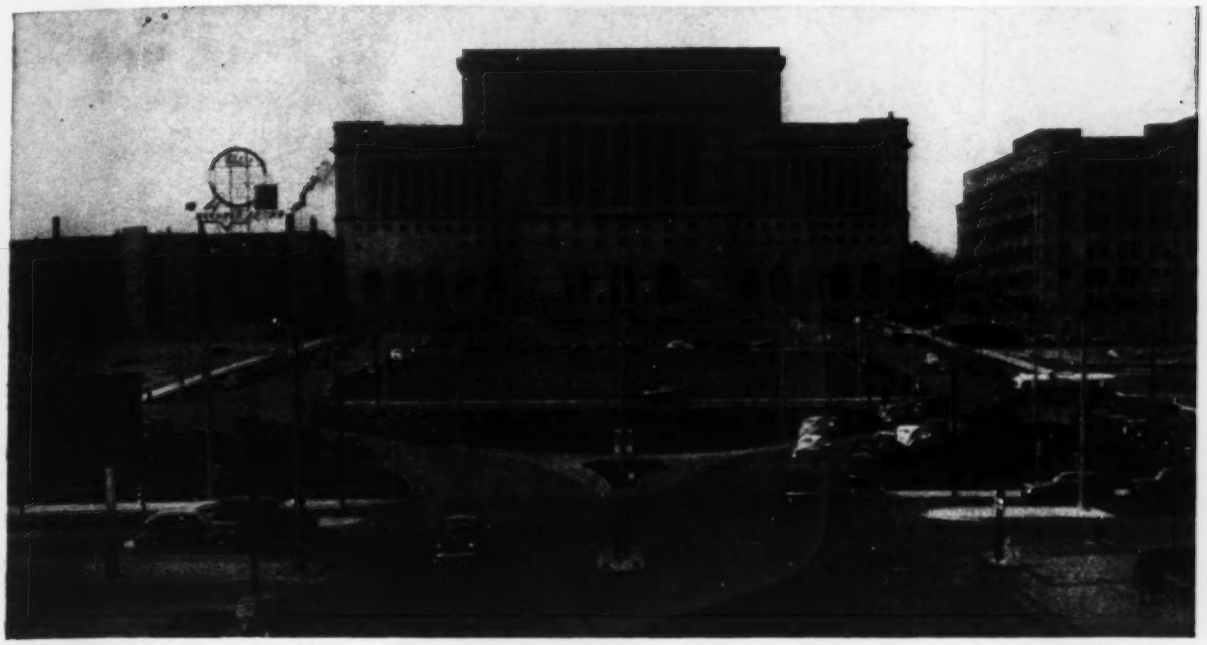
Pavement lengths and areas are the bases used in the preparation of all studies, reports and programs and will be used to a greater extent than any other information assembled on the card. Extreme care must be exercised to obtain factually correct information. Considering pavements only, the through length of a block is the average distance between the property line of intersections at either end of the block. Intersections have a through length similar to blocks and an additional "add length" in two or more directions depending upon the number of streets involved. The "add length" is the distance from property line to curb line (roadway line extended) and is found only at intersections (Fig. 1).

Measurements at intersections

The importance of add lengths at an intersection becomes evident when calculating the total length of all pavements within a fixed area of the city. All through lengths of blocks are taken as described previously, but a different procedure is used at intersections. At intersections it may be assumed arbitrarily that all through lengths will be taken with the streets in an east and west direction. Then the through length of north and south streets would be omitted at intersections to avoid duplication, but the add length in a north and south direction would be included. This provides the only method by which true pavement lengths can be obtained. As add lengths will vary but may be as great as 60 ft. at an intersection, these distances are worthy of consideration when block lengths average only 400 to 600 ft.

State-aid length is a local requirement due to the fact that the city obtains a motor-fuel tax refund from the state on the basis of the mileage of city streets both open and used.

The source of information for through lengths and street widths is a bound atlas prepared in quarter-sectional units to show all platted subdivisions by lot and block to the scale of 200 ft. to the inch. Unrecorded distances can be scaled with reasonable accuracy. After the street width is determined from the atlas, the combined sidewalk widths are deducted from it to obtain the roadway width. Continuing this procedure, the pave-



The street inventory system used in Milwaukee is flexible enough to provide an accurate record of an involved layout such as this widening of West Kilbourn Ave. leading into the municipal civic center.

ment width is computed by deducting the combined gutter width from the roadway width.

The pavement width is of primary importance because when used with the through length of a block it produces the pavement area within the block. In general, however, intersectional areas are computed by multiplying the through lengths in both directions and deducting from this product the area of four quarter circles at the corners (Fig. 1). The track zone has a width of 17.1 ft. which includes a 1-ft. strip outside both outer rails. Areas are obtained by multiplying the width by the through length.

Construction log record

On the inside page of the file card (Fig. 3, right), the construction log record represents a graphical presentation of the history of pavement construction by block and intersection. Contract information is entered in the same order as actual stage construction proceeds so that the original improvement will appear at the bottom of the card and the latest at the top. In addition, a color representing the pavement type is entered in the narrow band included with the description of each improvement. With this method of presentation, a complete picture of the history of construction can be grasped at a glance.

With each improvement is included such self-explanatory data as the year construction was completed, contract number, description and location of pavement type, Public Roads Administration classification of type of wearing surface, width and area of pavement for the specific contract, and type of curb and gutter. The unit cost refers to pavement construction and is given on a square yard basis unless otherwise indicated.

Past practices relating to reason and method of retirement of wearing surfaces will be studied to determine future policies relating to construction. The reason for retirement or replacement will be classified as due to structural failure, obsolescence, related construction, etc. Similarly the method of retirement falls into these categories, reconstruction, resurfacing, widening, vacation or abandonment, etc.

Much of the above information is taken from available contract records dating back to 1861. An intermediate gathering sheet is prepared for each contract. Then, the whole contract is divided into its respective blocks and intersections and the information is inserted on the construction log record. However, an unforeseen problem arose in this procedure because the location of the original contract is described by the street names in existence at the time of construction.

Frequent changes in street names have occurred subsequently and require a conversion to present-day street names before the location is known. Fortunately, a cross-reference listing was available for all present and past street names and numbers together with any changes which occurred during the years. Such a record is indispensible and must be prepared before contract information can be transcribed.

Provision for visible file indexing is made by reserving the last two lines on the inside page for a detailed description of the location of the block or intersection. The left one-third contains the name of the primary street and the right two-thirds, the names of the secondary intersecting streets or other limiting features.

The street inventory record is just the first stage in the complete road life study undertaken by Milwaukee. In addition to the present program for assembling basic construction inventory records, it is planned to revise the street maintenance cost accounting system to conform to block and intersection units so that both initial and maintenance costs will be available for analysis.

The Public Roads Administration has been of great assistance in the development of the basic procedures, particularly in planning the methods of gathering the information so as to facilitate its entry on the visual file and adapt itself to coding for the punch cards.

Design of Better Bridge Railings

Martin Deuterman
Associate Highway Bridge Engineer,
Public Roads Administration

***Contents in Brief**—Satisfactory bridge railings must be strong, sufficiently high, readily visible, provide adequate clearances, and present a continuous smoother barrier to traffic. At the same time the railing should be attractive in appearance and cause a minimum of interference to the view from the bridge. How the three functional parts of the railing—the curb, the rails or the horizontal barrier, and the posts or vertical supporting members—can best be designed to meet these varied requirements is discussed.*

A RECENT SURVEY of bridge railings by the American Association of State Highway Officials has revealed a great improvement in those important elements of bridges in the past few years. The flimsy inartistic types of handrails of the past have been developed into sturdy railings of more or less pleasing appearance. An analysis of the improvements shows that the function of bridge railings is being given greater consideration and that logical methods are now being used in their design. How these methods are applied is an interesting study.

The fundamental function of bridge railings is to protect vehicular and pedestrian traffic and the structure, but of only lesser importance in railing design is consideration of the pleasure of those persons using the bridge. These two aspects may be called the practical and esthetic aims of railing design.

Safety a major requirement

The practical considerations in the design and detail are the safety requirements, that is, the ability of the railing to withstand the forces due to collision by a vehicle with the least possible injury to occupants of the vehicle and with minimum damage to the vehicle and structure. Maximum safety also requires that the design reduce the probability of collision of vehicles with the railing or structure. These demands involve strength, smoothness, clearance and visibility. In addition, the esthetic considerations dictate that the railing impart a feeling of security without a sense of confinement and that it be of pleasing appearance and offer a minimum obstruction to the view.

In meeting the safety requirements it is not necessary to build a barrier of sufficient strength to stop the total movement of a vehicle. If the movement normal to the railing is checked, the vehicle will slide along or glance off a smooth railing. Although there is the danger of a vehicle glancing off the railing and colliding with another, the probability of damage and injury is much less than if the vehicle went through the railing. In most collisions with railings, the angle of contact is small so that the motion normal to the railing is only a minor part of the total motion of the vehicle.

Therefore, it can be assumed that the function of the typical railing is to protect average weight vehicles, traveling at reasonable rates of speed, with small angles of contact. On most bridges it would be impractical to design for excessive speeds, heavy trucks or large angles of contact. However, for bridges at hazardous locations and those on densely traveled routes and expressways, consideration must be given to increased railing height and strength and to additional clearance.

The strength requirements of railings have been developed from studies of barriers that have been struck by vehicles, rather than by mathematical analysis. The working stresses of the materials in the railing are used in the design, not the ultimate stresses. Members of the railings are considered to resist the design forces by their flexural strength, no allowance being made for inertia or axial tension in the rails.

With these general assumptions the best method of designing the three main functional parts of the railing will now be discussed in detail. These three parts are the curbs or restraining members, the rails or horizontal barriers and the posts or vertical supporting members.

The curbs and lower rails are the most effective parts in restraining vehicles and are designed accordingly. To provide adequate strength, a horizontal design force of 500 lb. per lin. ft. acting outward at the top of the curb is used. The two general types of curbs are the low, or unstepped design (Fig. 4) and the high or stepped curb (Fig. 1). Choice of the type of curb used is a matter of the designer's preference. There are, however, certain restrictions on the dimensions of both types.

Curb height restrictions

If the unstepped curb is used it should not be less than 9 in. nor over 10 in. Neither should the lower step of the stepped type be higher than 10 in. These restrictions are necessary because it has been found that a greater height will damage the running boards and fenders of passenger cars. To provide for added safety for passenger cars it is good practice to batter the inside faces of the curbs about 12 on 2. Also, a setback of 4 to 6 in. between the upper and lower portions of stepped curbs is desirable.

To accommodate the overhanging portions of trucks and to reduce the sense of constriction, adequate horizontal clearances must also be provided between the inside face of the curb and the rails and other parts of the structure. Generally, a clearance of from 12 to 18 in. is satisfactory, but where the curb is to be used as a safety curb it must be made 18 to 24 in. wide. A width of over 24 in. is considered a sidewalk, and must be so designed.

Where curbs are less than 20 in. high it is necessary to supplement them with low rails of greater strength than would be needed otherwise. In such cases most engineers design for a horizontal force of 500 lb. per lin. ft. of rail

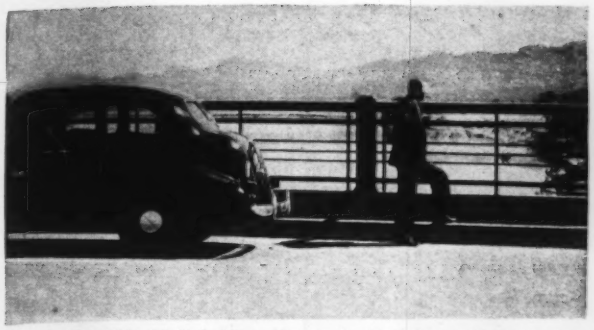


Fig. 1. On this high bridge the curb furnishes adequate protection to vehicles and the height of the railing provides security without spoiling the view.

Fig. 2. The smooth wall of this sidewalk railing provides a good barrier for vehicles and the design allows a wide latitude in treatment of the top rail.

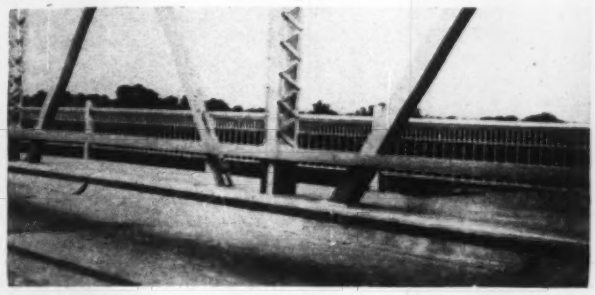


Fig. 3. For through bridges a strong rail attached to the trusses will protect vehicles and truss members alike.

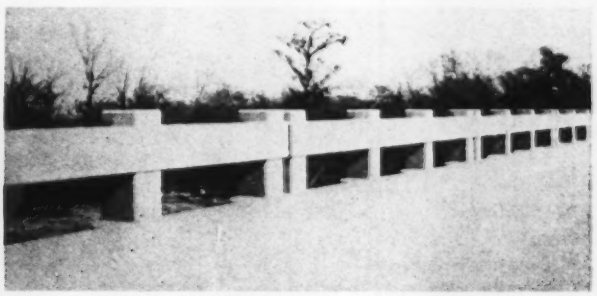


Fig. 4. For rural bridges a single wide rail projecting inside the posts provides good protection and is economical.

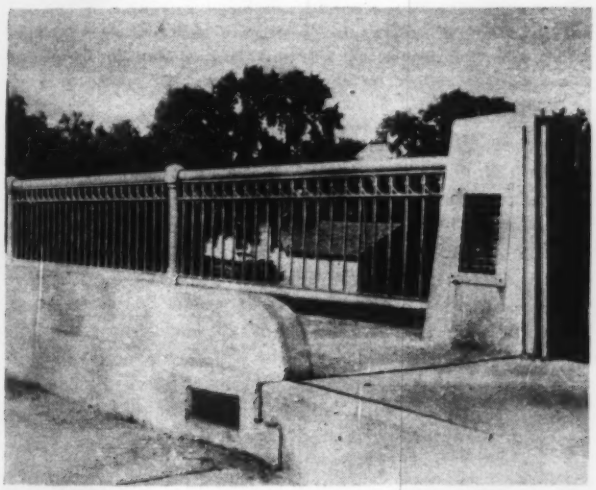


Fig. 5. Major protection on this bridge is the high-stepped curb, which permitted the use of an ornamental sidewalk railing causing little obstruction to the view.

Fig. 6. If built wide, sidewalk railings can be made low and still give feeling of security. Railings of this type also permit good architectural treatment of bridge.

acting outward. Other designers modify this load by using 150 lb. plus 35 lb. for each inch in curb height less than 20 in. with a maximum of 500 lb. for curbs 10 in. or lower. Generally, either of these methods proves satisfactory.

A horizontal design load of 150 lb. per lin. ft. acting outward is used in designing the upper rails. This load is also satisfactory for the rails used in conjunction with curbs 20 in. or more in height and the lower rail of sidewalk railings where a curb or truss railing is provided. Most designers consider it best to design sidewalk railings for the same forces as roadway railings, unless a curb 20 in. or more in height or a curb or truss railing is provided between the sidewalk and the roadway. The vertical load used in designing all rails is 100 lb. per lin. ft. Study of the service life of railings designed as outlined above indicate that these methods are highly successful.

Railings subject to highway traffic should present a continuous smooth surface on the roadway side (Fig. 4). The lower rail must project beyond the inside face of the posts and web members. Projection of the upper rail is also preferable, but is not as essential. This design will tend to keep cars from snagging on the barrier, the injury to per-

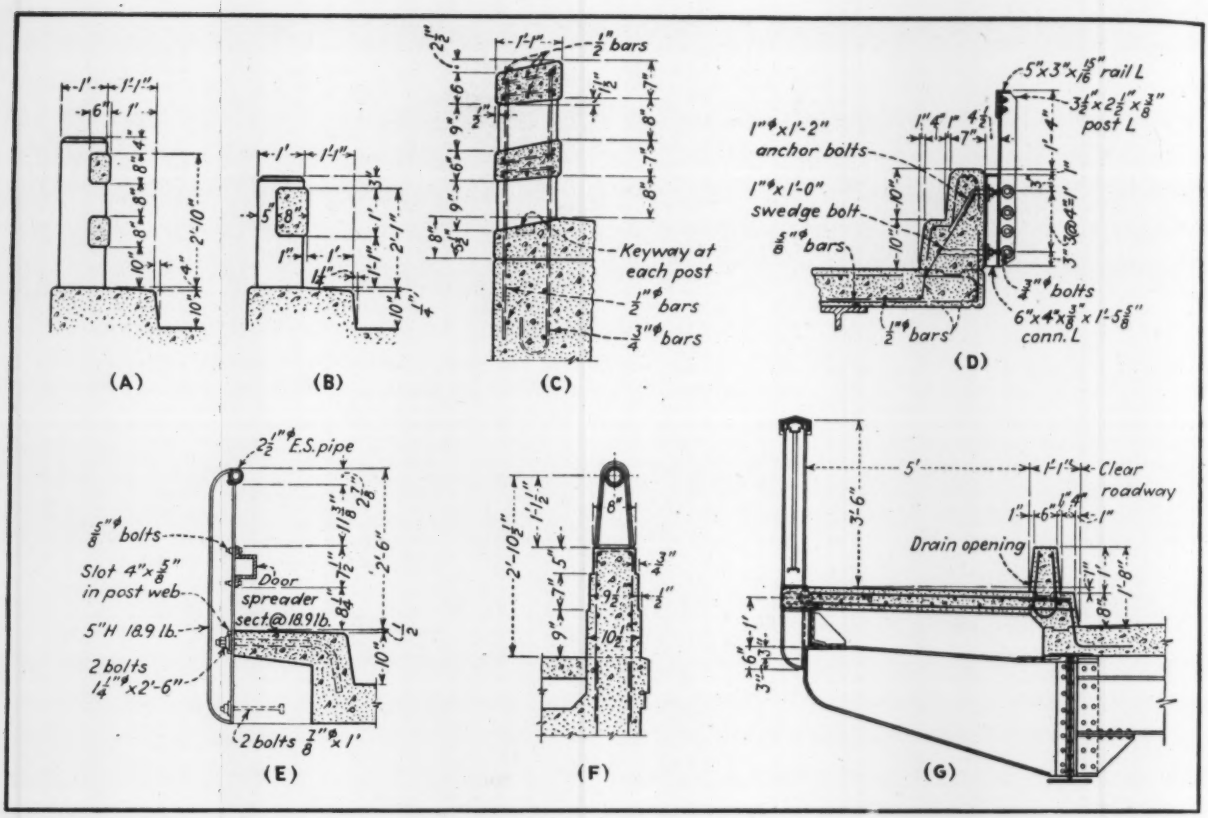


Fig. 7. Three good concrete railings with the rails projecting beyond the posts and presenting a smooth surface are railings A, B, and C, the latter being specially designed to permit a good view. On rural bridges a high-stepped curb and a single light steel rail (detail D) may be used. A somewhat different steel railing effective where no sidewalk is provided is shown by detail E. The smooth concrete barrier at the base of railing F permits a light rail to be used at the top. Of much different design but equally satisfactory is railing G.

sons and vehicles being less if cars slide along or glance off than if they snag on the railing.

The lower rail should have its center at least 12 in. above the curb of sidewalk so that vehicles will be more apt to strike this member instead of the posts or web members (Fig. 7A). It is also preferred that this rail have a wide verticle face, say a minimum of 8 in. for roadway railings and 6 in. for sidewalk railings.

The snagging effect on other types of railings may be reduced by making the railing smooth and free from projecting posts for a height of 12 in. or more above the curb or sidewalk (Fig. 2). Above this smooth surface, ornamentation and light rails may be used. Where sidewalks are provided outside of the trusses, a high curb or a sturdy single-rail railing secured to the truss members on the roadway side is desirable to protect traffic and the trusses alike (Fig. 3).

Adequate size of members and height of railings tend to give the occupants of vehicles a feeling of security. A height of 3 ft. 3 in. above the roadway surface is the preferred minimum for the usual types of roadway railings. However, for rural bridges a railing with an unstepped curb and with one strong wide-face rail projecting inside the posts may be used satisfactorily (Fig. 7B). The height of these railings can be made less than usually recommended, provided the inside face of the rail is made 12 in. wide and the top of the rail at least 2 ft. 9 in. above the roadway surface.

Railings along sidewalks

Higher railings are needed outside of sidewalks to give safety and a feeling of security to pedestrians (Fig. 7G). A 3-ft. height above the sidewalk surface is an acceptable minimum. However, this height may be reduced to 2 ft. 3 in. and still provide a feeling of security, provided the tops of the rails are relatively wide (Fig. 6). But the sum of the height and one-half the top width should not be less than 3 ft.

When designing sidewalk railings the matter of openings in the railings must also be considered. For maximum safety of pedestrians and to prevent children from climbing through the railing, openings of not more than 8 in. wide are preferred.

Cracks and bad alignment of the railing due to expansion and contraction stresses from the main structure will usually occur if the expansion joints in the railing are not properly spaced and of adequate design. If concrete railings are used, open expansion joints are preferable to filled joints. With the latter the fill material may be extruded when the joint closes or it may fall out when the joints open.

The posts must be designed to withstand the simultaneous action of the design forces applied to the rails. In the past, the design of the posts and connections frequently received too little attention. The most frequent point of weakness of steel and timber rails is the connection of the posts to the main structure. However, adequate strength can be readily obtained for the connection to steel bridges.

The connection of the posts to timber

structures without cumbersome details is more difficult. In the past, lower design loads were permissible for timber railings, since a stronger railing acquired costly connections and since this type of railing was used primarily on bridges on secondary roads. However, with the more general use of special timber connectors, it may become feasible to increase the strength of post connections so that timber railings will comply to the general design standards.

It has been noted that when concrete railings have been broken by the impact of vehicles the concrete usually breaks away from the reinforcement, and the posts slip along the construction joint where the posts bear on the top of the curb. These failures indicate that the resistance of concrete railings may be improved by increasing the cover of the reinforcing steel and by using adequate shear keys.

Designing for beauty

Aside from their practical value, railings are important elements in enhancing the appearance of a bridge. They are the most prominent members of the structure that the users see, especially on deck bridges. It is encouraging to note that the A.A.S.H.O. study reveals that the beauty of railings is receiving increased attention by the designer.

To give a pleasing impression, the materials and architecture of the railings should be such as to harmonize with the bridge and the surrounding landscape or nearby structures. Generally it is better to accentuate the horizontal lines of the railings, although the use of web members to restrict the size of openings makes this difficult on sidewalk railings. Panelling and grooving, if tastefully employed, will improve the appearance of some types of railings. The appearance of concrete railings can be further improved by careful design of the forms and by skillful finishing of the exposed concrete.

While all railings obstruct the view somewhat, this obstruction should be reduced to a minimum consistent with safety. High solid railings not only obstruct the view, but on bridges without sidewalks give an undesirable sense of confinement. When there are curves or intersections at the ends of bridges, unobstructive railings are especially necessary for safety.

The design problem is to minimize the height of solid web railings and reduce the size of the members of high railings, since the view from the bridge is over or through the railing. Strong wide-faced single-rail railings as low as 2 ft. 9 in. above the roadway surface and relatively wide sidewalk railings as low as 2 ft. 3 in. above the sidewalk level are used successfully. However, these low railings are not advisable for high bridges. Small members are utilized for upper rails and rails used in conjunction with high curbs, truss railings or curb railings. A single rail designed as a lower rail is preferable for truss and curb railings. The tops of rails and solid railings are sometimes sloped downward to reduce the obstruction to the view (Fig. 7C).

Small spindles may be used on sidewalk railings since they are primarily to protect only pedestrian traffic. But they should not be too small for good appearance. A wide spacing of spindles offers less obstruction to the view through the railings, provided the openings do not exceed 8 in. for reasons mentioned previously.

Posts projecting above the top rail usually detract from the appearance of railings; on the other hand, small irregularities in the grade and alignment of the top rail are readily noticeable when the posts are not projected. Because these irregularities are difficult to eliminate, the posts are usually carried a small distance above the top rail. However, with proper care in fabrication of steel railings, and careful work in constructing concrete railings these irregularities may be eliminated and the tops of the posts placed at or below the top of the railing. A trend in this latter direction is indicated by the A.A.S.H.O. survey.

End posts stepped or curved down away from the ends of bridges generally look better than those of uniform height. Flaring them improves the appearance, as well as increasing visibility.

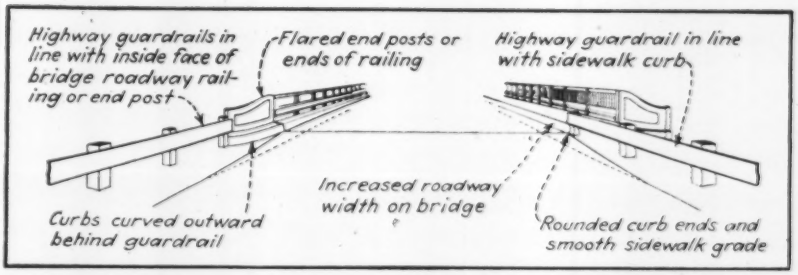

Highway guardrails in line with inside face of bridge roadway railing or end post
Flared end posts or ends of railing
Highway guardrail in line with sidewalk curb
Increased roadway width on bridge
Curbs curved outward behind guardrail
Rounded curb ends and smooth sidewalk grade

Fig. 8. Care must be exercised in the layout of the railings and curbs at the ends of bridges. Six major requirements for good approaches are illustrated.

The ends of bridges are potentially dangerous to vehicular travel due to the change in driving conditions, hence this factor must receive careful attention in designing railings, both from the standpoint of utility and beauty. The designer may well take the view that accidents at the ends of bridges are caused by the barriers and restrictions imposed, rather than to the carelessness of drivers. This view leads to careful design to reduce the probability of vehicles hitting the end of railings, curbs or sidewalks. Widened roadways, highway guardrails, improved reflectors and flared ends of curbs and railings are used to increase the safety (Fig. 8).

Guard rails at bridge ends

Roadway guardrails should be lined up with the ends of the railings to provide a continuity of protection; on bridges with sidewalks and without curbs on the adjacent highway the guardrails are sometimes placed in line with the curbs. In any case, the sidewalks and curbs should be brought to the shoulder grade on an easy slope instead of ending in a step. The hazard of curb ends should be further reduced by curving the end of the curb and by stopping the curb outside the line of the guardrail. Flared endposts also add greater safety, since if a post of this type is struck the damage will be less than for square ends. Properly placed reflectors should also be used to increase the visibility of end posts and curbs at night.

To summarize, from the standpoint of safety the railings of bridges must provide adequate strength, smoothness, and clearance and be readily visible. Architectural balance and minimum obstruction to the view are equally essential for good appearance and the pleasure of persons using the bridge. The attainment of these features requires careful application of engineering and architectural principles.

Book Notes and Reviews

The month's addition to the engineer's reading and reference list

Civil Engineering Design

DATA BOOK FOR ENGINEERS: Volume I—Design—By Elwyn E. Seelye, 417 pp. John Wiley & Sons, New York. $7.50.

This book, which is the first volume of a three-volume Data Book for Civil Engineers, is difficult to appraise. It contains an impressive array of the type of information that an engineer likes to keep at hand, convenient charts, tables and nomographs reproduced on large pages for legibility. Doubtless much of the material reproduced in the book was accumulated by the author from many sources in a very active and varied career. Hence many engineers will find this big book a valuable asset.

On the other hand, the book cannot be said to come up to the author's objective of producing a book that would permit "engineers isolated from other reference books to function." In some fields of civil engineering such as airport design that might be true, but in other fields such as dam design, railroads and bridges it is not true. This first edition lacks balance, which can be corrected in later editions.

The author and his assistants are to be commended for their energy in assembling this data and preparing the many charts.

Anecdotes of the P.G.C.

PERSIAN GULF COMMAND—By Joel Sayre. 140 pp. Random House, New York. $2.

Although Iran, or Persia, because of the international bones of contention that litter its terrain is never likely to be a forgotten member of the family of nations (witness the current Russian incident in its province of Azerbaijan) thousands of American G.I.'s have another more certain reason for rememberance. They lived there, and they worked there. Some of their buddies died there.

One of the toughest jobs an American soldier could draw in the war was an assignment to the Persian Gulf Command where, as a railroad hand, a ship stevedore or a construction stiff, he was helping in the critically important task of building and operating our supply lines to Russia, but where he also was beset by the worst of heat and humidity in summer, by bitter cold in winter, and by lonesomeness, disease and desolate vistas all the time. The natural result was that he soon began grousing about his luck and bewailing his condition until he created thereby a whole batch of what might be called folklore. It required only a reporter with a photographic eye, a memory for anecdotes and a sense of humor to make a readable book out of what at the time seemed like the incidents of a "Lousy way of life".

Joel Sayre is such a reporter who wrote most of his material first for *The New Yorker*, and then made a book out of it. He doesn't miss many of the interesting and unusual situations that the boys found or created in the P.G.C., which as he points out, stands for "People Going Crazy" as well as for Persian Gulf Command. He also mentions another set of G.I.-invented initials, "F.B.I.", standing for "Forgotten Bastards of Iran", but fails to list "B.B.B.", the "Bitching Bastards of Basra", an organization to which both he and the present reviewer, who battled the heat for a week under adjacent mosquito netting, can claim membership.

Sayre writes with understanding and appreciation of the great contribution made by the men of the P.G.C. to the winning of the war. But his principal purpose is to recall and tell with a light and humorous touch the anecdotes that went the rounds of the camps. More little books like this one should be written about the other war theaters—W.G.B.

Through Colored Glasses

UNCLE SAM'S BILLION DOLLAR BABY—A Taxpayer Looks at the TVA—By Frederick L. Collins. 174 pp. G. P. Putnam's Sons, New York. $2.50.

This is not an engineering book. Our purpose in commenting on it here is two-fold: First, because engineers who are interested in river development work are reading it in the hope of learning more about the Tennessee Valley Authority; and second, because the author, who is not an engineer, undertakes to give his readers information on an involved engineering subject, the design and use of multiple-purpose reservoirs.

The book is a cleverly written piece of anti-TVA literature. It all sounds very plausible. But when the engineer reader discovers some obvious misstatements of fact and half truths with respect to engineering matters he begins to suspect that the same may be true of the author's statements with respect to the TVA financial operations.

The fact that the author's statements condemning multiple-purpose reservoirs follow the same pattern as those appearing elsewhere during the past year suggests that the author based at least part of his book not on his own research but on information supplied to him by spokesmen for the privately owned electric utilities as part of an organized campaign against public power development.

The book needs to be appraised in the light of that probability.

New Engineering Books

EXPERIMENTAL STRESS ANALYSES—VOLUME III, No. 1—Proceedings of the Society for Experimental Stress Analyses. 154 pp. Addison-Wesley Press, Cambridge 42, Mass. $5.

A TREATISE ON APPLIED HYDRAULICS—Third Edition. By Herbert Addison. 614 pp. John Wiley & Son, New York, and Chapman & Hall, London. $6.50

MECHANICS FOR ENGINEERS—By Edward R. Maurer, Raymond J. Roark, George W. Washa. 425 pp. John Wiley & Sons, New York, Chapman & Hall, London. $4.

SALARY & WAGE ADMINISTRATION—By Ralph W. Ells. 120 pp. McGraw-Hill Book Co. New York and London. $1.50

ATOMIC ENERGY IN WAR & PEACE—By Gessner G. Hawley & Sigmund W. Leifson. 211 pp. Reinhold Publishing Corp., New York 18. $2.50

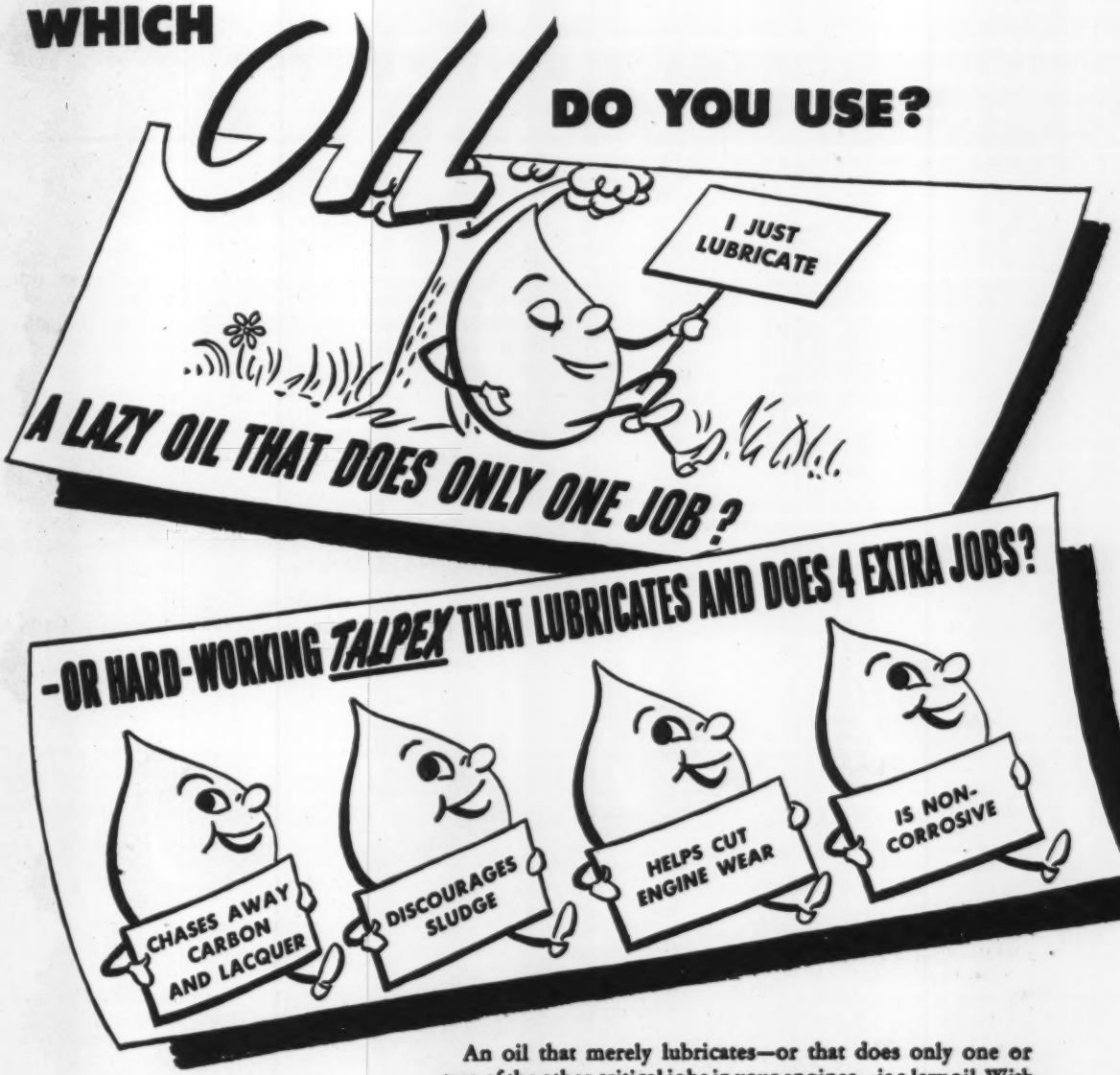
LABOR POLICY OF THE FEDERAL GOVERNMENT—By Harold W. Metz. 284 pp. The Brookings Institute, Washington 6, D. C. $2.50

SUPERVISING PEOPLE—By George D. Halsey. 233 pp. Harper & Bros., New York. $3.

DATA BOOK FOR CIVIL ENGINEERS: VOLUME I—DESIGN—By Elwyn E. Seelye. 417 pp. John Wiley and Sons, New York. $7.50.

(*Continued on page* 172)

WHICH OIL DO YOU USE?


I JUST LUBRICATE
A LAZY OIL THAT DOES ONLY ONE JOB?
-OR HARD-WORKING TALPEX THAT LUBRICATES AND DOES 4 EXTRA JOBS?
CHASES AWAY CARBON AND LACQUER
DISCOURAGES SLUDGE
HELPS CUT ENGINE WEAR
IS NON-CORROSIVE

An oil that merely lubricates—or that does only one or two of the other critical jobs in your engines—is a lazy oil. With today's operating conditions . . . the high cost of repairs . . . the scarcity of good spare parts . . . you simply can't afford to use a lazy oil.

To get the utmost in performance from your engines, use hard-working Shell TALPEX. This versatile oil has *all* the properties needed to do the many critical jobs necessary to keep your engines running smoothly and efficiently under the most severe operating conditions.

SHELL TALPEX

1. Has high detergency. Helps keep carbon, lacquer and foreign particles from adhering to pistons and rings, valves, ports.
2. Has exceptional Oxidation Stability. Holds to a minimum the formation of sludge, lacquer and other products of deterioration.
3. Has low Carbon-Forming Tendency. Reduces ring sticking and wear. Lengthens engine life.
4. Is non-corrosive to alloy bearings. Protects all lubricated engine parts against corrosion.

If the oil you now use is not doing all these jobs, it's lazy—should be changed to hard-working Talpex. Ask the Shell man to show you why.

SHELL

TALPEX

THE ALL-PURPOSE, HEAVY-DUTY LUBRICANT

for trucks, buses, tractors, shovels, stationary and marine Diesels.

CONTRACT UNIT PRICES

What contractors are bidding on different kinds of construction work

HIGHWAY CONSTRUCTION IN OREGON

Clearing

OWNER: Oregon State Highway Commission, Salem, Oregon. Mr. R. H. Baldock, state highway engineer.

PROJECT: Circle Bridge-Hug Point Section, Oregon Coast Highway. 7.41 miles or approximately 164 acres of highway right of way clearing.

CONDITIONS: Contractor to complete project in 240 calendar days. Minimum wage rates are: Skilled Labor $1.25 per hour, Intermediate Labor, Group 1, $1.15 per hour; Intermediate Labor, Group 2, $1.00 per hour, Common Labor, $0.85 per hour.

BIDS: Six bids were received October 29, 1945, ranging from $119,500.00 to $258,750.00.

PARTIAL LIST OF BIDDERS:

1. J. R. Maginnis, Portland, Oregon $119,500.00
2. Grimstead and Vandervelt, Astoria, Oregon 133,000.00
3. Heavy Hauling Company, Astoria, Oregon 151,200.40

Item	Quantity	Unit Prices (1)	(2)	(3)
1. Clearing	Lump Sum	$116,000.00	$130,000.00	$138,842.40
2. Extra clearing	5 acres	600.00	500.00	846.60
3. Felling danger trees	500 sq. ft.	1.00	1.00	16.25

Grading

PROJECT: Troutdale-Wahkenna Creek Section, Columbia River Highway. 2.49 miles of grading, requiring approximately 206,000 cubic yards Borrow Excavation; 231,000 cubic yards Roadbed Excavation, and 7,000 cubic yards Channel Change Excavation.

CONDITIONS: Contractor to furnish all materials and complete project in 300 calendar days. Minimum wage rates are: Skilled Labor $1.25 per hour; Intermediate Labor, Group 1, $1.15 per hour; Intermediate Labor, Group 2, $1.00 per hour, and Common Labor $0.85 per hour.

BIDS: Eleven bids were received October 29, 1945, ranging from $149,705 to $198,255.

PARTIAL LIST OF BIDDERS:

1. Leonard and Slate Oregon, Ltd., Portland $149,705
2. Berke Bros., Portland 150,192
3. R. A. Heintz Construction Co., Portland 158,896

Item	Quantity	Unit Prices (1)	(2)	(3)
1. Clearing and grubbing	All Specified	$10,000	$17,800	$12,500
2. Structural excavation	60 cu. yds.	4.00	2.00	3.00
3. Trench excavation	600 cu. yds.	1.50	2.00	2.00
4. Borrow excavation	206,000 cu. yds.	0.20	0.19	0.22
5. General excavation, location "A"	213,000 cu. yds.	0.20	0.19	0.225
6. General excavation, location "B"	12,000 cu. yds.	0.20	0.19	0.30
7. General excavation, location "C"	6,000 cu. yds.	0.50	0.19	0.30
8. Channel change excavation	7,000 cu. yds.	0.70	1.00	1.00
9. Short overhaul	1,900,000 yd. stas.	0.01	0.01	0.01
10. Long overhaul	40,000 "C" yd. stas.	0.40	0.35	0.30
11. Rounding cutbanks	7,000 lin. ft.	0.10	0.10	0.15
12. Finishing roadbed and slopes	2.49 mile	500.00	300.00	250.00
13. 18" corrugated metal pipe, protected invert	440 lin. ft.	3.00	3.00	2.39
14. 24" corrugated metal pipe, protected invert	450 lin. ft.	4.00	4.00	3.55
15. 36" corrugated metal pipe, protected invert	130 lin ft.	10.00	7.50	7.50
16. Topsoiling, tractor and carryall	250 hours	11.00	9.00	11.00
17. Topsoiling with blade grader	50 hours	7.00	5.00	6.50

Surfacing and Oiling

PROJECT: Buchanan-Malheur River Section, Central Oregon Highway. 18.80 miles of surfacing and oiling; also furnishing 11,400 cubic yards of crushed rock in stockpiles. Requires approximately 82,700 cubic yards crushed rock, and 1,054 tons of asphaltic materials.

CONDITIONS: Contractor to furnish materials and complete project in 335 calendar days. Minimum wage rates are: Skilled Labor, $1.25 per hour; Intermediate Labor, Group 1, $1.15 per hour; Intermediate Labor, Group 2, $1.00 per hour; Common Labor, $0.85 per hour.

BIDS: Eight bids were received October 30, 1945, ranging from $235,479 to $334,426.

PARTIAL LIST OF BIDDERS:

1. Rogers Construction Co., Dayton, Wn. $235,479
2. E. C. Hall Co., Portland 236,020
3. Newport, Kern and Kibbe, Portland 247,960

Item	Quantity	Unit Prices (1)	(2)	(3)
1. 3½"-2" rock in base	38,000 cu. yds.	$2.10	$2.10	$2.39
2. ¾"-0" rock in base & shoulders	21,000 cu. yds.	2.25	2.10	2.39
3. Sprinkling	1,400 M-gals.	3.00	2.50	3.50
4. Preparation of base	18.77 miles	100.00	125.00	100.00
5. Furnish and place aggregates	12,300 cu. yds.	3.00	3.40	2.84
6. Furnish and place 151-200 asphalt	820 tons	33.00	32.00	33.46
7. Furnish and place RC 3 or emulsified asphalt	234 tons	33.00	32.00	31.70
8. ¾"-1½" crushed rock in stockpiles	4,560 cu. yds.	2.55	2.59	2.49
9. ½"-¾" crushed rock in stockpiles	3,420 cu. yds.	2.55	2.59	2.49
10. ¼"-0" crushed rock in stockpiles	3,420 cu. yds.	2.55	2.59	2.49
11. Clearing and grubbing stockpile sites	Lump Sum	800.00	600.00	1,000.00
12. Leveling of stockpile sites	Lump Sum	800.00	600.00	1,000.00

Bituminous Macadam Surfacing

PROJECT: Madras-Juniper Butte Section of The Dallas-California Highway. 10.41 miles of bituminous macadam surfacing. Requires approximately 26,200 cubic yards pit-run gravel topping; 88,000 cubic yards crushed rock, and 1,128 tons of asphaltic materials.

CONDITIONS: Contractor to furnish all materials and complete project in 365 calendar days. Minimum wage rates are: Skilled Labor $1.25 per hour; Intermediate Labor, Group 1, $1.15 per hour; Intermediate Labor, Group 2, $1.00 per hour; Common Labor, $0.85 per hour.

BIDS: Fifteen bids were received October 29, 1945, ranging from $226,311 to $347,667.

PARTIAL LIST OF BIDDERS:

1. J. N. & M. J. Conley, Portland $226,311
2. Rogers Construction Co., Dayton, Wash. 239,088
3. Newport, Kern & Kibbe, Portland 264,626

Item	Quantity	Unit Prices (1)	(2)	(3)
1. Selected Roadbed Topping	26,200 cu. yds.	$0.30	$0.58	$0.43
2. Hauling Roadbed Topping	76,200 yd. miles	0.09	.10	0.125
3. 4½"-2" rock in base	42,500 cu. yds.	1.75	1.95	2.26
4. ¾"-0" rock in base and shoulders	30,000 cu. yds.	1.90	1.95	2.26
5. Sprinkling	2,000 M-gals.	2.75	2.50	2.00
6. Preparation of base	10.41 miles	175.00	100.00	100.00
7. Hauling and placing aggregates	800 cu. yds.	1.35	1.40	1.30
8. Furnishing and placing aggregates	15,500 cu. yds.	2.70	2.50	2.84
9. Furnishing and placing 121-150 asphalt	980 tons	26.50	25.50	26.56
10. Furnishing and placing RC-3 or emulsified asphalt	148 tons	27.00	27.00	26.05

Q Are you all set today for the jobs immediately ahead?

Q Is "on the job" lubrication costly?

A If you're not—you should be! Make sure *now* that your machines will have less "down time," cost less to maintain, yet produce more work. For example: one contractor cut track roller and other bearing failure 25%—saved up to 20% on lubricants by switching to Alemite "on the job" power lubrication. "Down time" saved became *extra* productive time. An Alemite Portable Service Station can help you meet tomorrow's tougher competition!

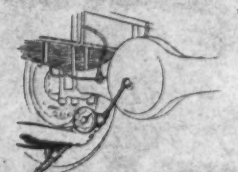
A On the contrary—an Alemite Portable Service Station pays for itself by saving money! Take the case of the contractor who was losing money on 5 machines because of slow lubrication methods. A Portable Service Station brought power lubrication *to* the machines . . . cut lubricating time 50% . . . gave him an hour and forty minutes More Productive Time *per day!* The savings in maintenance, machines and time soon paid for the new method.

LOOK HOW VERSATILE!

Fast, easy lubrication of track rolls and all bearings having pressure gun fittings.

No time or oil wasted in filling crank cases, or other oil containers, with the amounts desired.

Air line equipment for tire inflation, air jet cleanings, engine cleaning, paint spraying, etc.



Quick and precise dispensing of gear lubricants to gear housings, transmissions, final drives, etc.

Save Time, Money and Machines with an Alemite Portable Station!

1. It saves time by bringing *positive* power lubrication *to* your machines. They need not leave the job.
2. It saves money by cutting "down time"... increasing productive time.
3. It saves machines... makes them last longer ... by reducing bearing failure due to faulty lubrication.

Alemite Portable Service Stations come complete with high and low pressure barrel pumps, oil dispenser, hose reels and gas engine air compressor. The time, money and machines you save can be of tremendous help in showing additional profit on contracts.

FREE: Illustrated catalog describing Alemite Portable Service Stations. Also, complete Catalog of individual Alemite lubricating equipment. Send coupon for your copies.

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And *Only* ALEMITE Combines ALL 3 In Lubrication

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Company _____
Name _____
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City _____ State _____

MATERIALS AND LABOR PRICES

Market quotations on construction materials and wage rates reported monthly by ENR correspondents

CONSTRUCTION MATERIAL and labor rates reported in January to *Engineering News-Record* record several changes from the preceeding month. The OPA acting to speed new construction has announced the following changes: The manufacturing prices for all types of Portland cement—except white cement—have been raised 20c. a barrel in Nebraska, Kansas, Oklahoma, Arkansas, and Western Missouri, as well as, Idaho, Montana, Wyoming, Utah, Colorado and New Mexico. An increase of about 9.7 percent in ceiling prices for sales of vitrified clay sewer pipe and allied products in East and East Central States, effective Dec. 17, 1945. In New York City, the Wage Adjustment Board approved wage increases averaging slightly under the 15 percent Little Steel formula for 200,000 building trades and heavy construction workers, as a result carpenters wages went from $1.85 to $2.10; structural ironworkers from $2.00 to $2.25; laborers went from $1.10 to $1.20. In Boston, wage increases were reported for bricklayers; $1.625 to $1.725 per hr., carpenters; $1.50 to $1.60, structural iron workers, from $1.675 to $1.735; and common labor went from $1.00 to $1.15. In Cincinnati cement in cloth bags dropped to $2.51, while paper bags and bulk went to $2.26 and $2.06 respectively. Kansas City also raised prices on cement; cloth bagged going from $2.58 to $2.78. The new cement regulation, OPA explained, freezes manufacturers' ceilings at the amount they charged for deliveries completed between March 1 and March 15, 1942, and provides for adjustments for changes in actual transportation cost. Basing point dollar and cent ceilings that vary according to delivery points established. Cast Iron Pipe has been raised in all ENR cities $1.00 over the preceeding month. In Los Angeles, common labor wage rates went from $0.875 to $1.00 per hr. Minneapolis recorded a 6c. raise in sheet piling, making the new price $2.79; ⅝ in. reinforcing bars also went up 6c. and are now quoted at $2.79. Philadelphia and Pittsburg reflected the raise in structural clay tile products and are now selling at the higher prices. In St. Louis plasterers' wages jumped 15c. and are now at $1.90 per hr.

CEMENT, AGGREGATE, READY-MIXED CONCRETE—F. O. B. CITY

	PORTLAND CEMENT (Per bbl., C/L lots, incl. 40c. per bbl. for bags, cash dis. not deducted)			SAND AND GRAVEL (Per ton, carload lots)			CRUSHED STONE (Per ton, carload lots)		CRUSHED SLAG (Per ton, carload lots, f.o.b. plant)		CONCRETE BLOCK 8x8x16-in.; truckload del.; per block		READY MIXED CONCRETE 1:2:4, over Ready Mixed Sand-grav. Lt.wgt. Agg. 50 c.y., del.
	Cloth *a*	Paper	Bulk	Gravel, 1½ in.	Gravel, ¾ in.	Sand	1½ in.	¾ in.	1½ in.	¾ in.	Sand-grav.	Lt.wgt. Agg.	
Atlanta	$2.77	$2.52	$2.47	$1.79	$1.89	$1. 68	$1.79	$1.89	$1.59	$1.69	$0.17	....	$8.30
Baltimore	2.62	2.37	2.12	1.80‡	1.80‡	1.30‡	1.80‡	1.80‡	1.75‡	1.75‡	.125	$0.125*w*	7.45
Birmingham	2.50	2.25	2.10	1.75	1.75	1.50	.85	1.00	.90	1.15	.1425	....	5.80
Boston	2.99*b*	2.72*b*	2.52	1.50‡	1.50‡	1.05‡	1.25‡	1.35‡	....	....	.13	.155*w*	7.55*m*
Chicago	2.90	2.65	2.50	2.15‡*d*	2.15‡*d*	2.15‡*d*	2.15‡*d*	2.15‡*d*	1.75‡	1.75‡	.18	.18*x*	....
Cincinnati	2.51	2.26	2.06	1.20	1.20	1.10	1.80	1.80	....	....	.12	.15*w*	6.70
Cleveland	2.59	2.34	2.19	1.75*i*	1.75*i*	1.25/1.65*i*	1.80*i*	1.80*i*	1.15	1.15	.14	.14	7.45
Dallas	2.51	2.26	2.06	1.50*p*	1.70*p*	1.10*p*	1.69*p*	1.79*p*	....	....	.15	....	7.15
Denver	3.32	2.72	2.47	1.20	1.25	1.90	1.65	1.75	1.00	1.00	....	.15	9.10
Detroit	2.59	2.34	2.19	1.50	1.50	1.30	2.25	2.25	2.00‡	2.00‡	.14	.15*w*	7.25
Kansas City	2.78	2.57	2.38	1.85	2.30	1.00	1.91	1.91	....	....	.125	.125*wy*	7.50*m*
Los Angeles	3.20*v*	2.60*v*	....	1.30	1.30	1.15	1.30*f*	1.30*f*	....	....	.04*bb*	.10*aa*	7.25
Minneapolis	3.07	2.82	....	1.00*k*	1.00*k*	.25*k*	1.00*k*	1.00*k*	....	....	.14	....	7.80*j*
Montreal	....	1.95*r*	1.79*r*	1.65‡*s*	1.65‡*s*	1.50*t*	.80*ct*	.90*ct*	....	....	.17*t*	.17*wt*	7.85*ls*
New Orleans	2.41	2.16	1.92	1.67	1.65	1.22	....	....	.90	1.15	.19	....	9.25
New York	2.85‡	2.60‡	....	1.60*de*	1.60*de*	.90*de*	1.80*de*	1.80*de*	....	....	.16	.14*wcc*	8.25*k*
Philadelphia	2.73	2.48	2.28	1.55‡	1.65‡	1.20‡	1.90	1.95	1.10	1.10	.155	.155*w*	8.55
Pittsburgh	2.80	2.55	2.35	1.65‡	1.65‡	1.85‡	2.25‡	2.25‡	1.50	1.50	.17	.17*z*	8.40
St. Louis	3.00	2.72	....	1.75‡	1.75‡	1.25/1.40‡	1.25*h*	1.25*h*	.90*g*	1.10*g*	.155	.135*w*	8.60
San Francisco	2.21	2.01	1.71	1.36	1.36	1.36	1.46	1.46	....	....	....	.21*y*	7.55
Seattle	2.75*o*	3.00*o*	....	2.35*d*‡	2.35*d*‡	2.35*d*‡	2.85‡*od*	2.85‡*od*	....	....	.16	.16*y*	7.25

‡ Delivered. *a* 10c. allowed for each returnable bag. *b* 10c. per bbl. off for cash. *c* F.o.b. quarry. *d* Per cu. yd. *e* Barge lots alongside docks. *f* Crushed granite. *g* F.o.b. Granite City, Ill. *h* F.o.b. plant. *i* Within three miles of Public Square. *j* 5% discount for cash. *k* Discount of 2 percent for cash in 10 days. *l* Up to 200 cu. yd. *m* 50c. off for cash. *n* 25 c.y. or more. *o* 2% off for cash. *p* 10c. per ton off, cash 15 days. *r* 10c. per bbl. off, cash 20 days. *s* 8% sales tax included. *t* 8% sales tax not included. *u* Withdrawn. *v* 20c. per bbl. discount; 20c. allowed for returnable cloth bag. *w* Cinder. *x* Waylite. *z* Celocrete. *aa* Pumice. *bb* 4 x 8 x 12 in. *cc* Also 8 x 18 x 18 in.

CASH DISCOUNTS CEMENT to Contractors: truck delivery, 2% for cash on 10th of month; on carload deliveries, no trucking, same as dealer cash discount 10c. per bbl for payment within 15 days of date of invoice. Subject discount 10c. per bbl. 20 days in Montreal.

CURRENT MAXIMUM PRICE BASES AT CEMENT MILL

Charge for bags not included. For cloth bags, add 40c per bbl.; 10c. refund allowed for each returnable bag; for paper bags add 15c. per bbl., not refundable.

	Bagged	Bulk		Bagged	Bulk		Bagged	Bulk
Buffington, Ind	$1.90	$1.85	Ironton, Ohio	$1.80*	$1.75*	Richard City, Tenn	$1.80	$1.75
Dallas, Tex	....	....	Limedale, Ind	....	....	Steelton, Minn	2.00	1.95
Hannibal, Mo	1.90	1.85	Norfolk, Va	....	....	Universal, Pa	1.85	1.80
Hudson, N. Y	....	....	Northampton, Pa	1.75	1.70	Waco, Tex. (Plus 9c. tax in Tex.)	1.75	1.70
Independence, Kans	1.90	1.85	North Birmingham, Ala	....	....	Montreal City (Discount 10c. per bbl. 20 days)	1.68	1.67

* Destination price base; effective Sept. 17, 1945.

PAVING BRICK, BLOCK, ASPHALT, ROAD OILS—F. O. B. CITY

	PAVING BRICK AND BLOCK			PAVING ASPHALT (Per ton, less than 80 penetration)		ASPHALT BINDERS—FLUXES (Per gal., 80–300 penetration)		CUTBACK ASPHALT (Per ton)		ROAD OIL (Per gal.)	ASPHALT EMULSION (Quick-breaking) (Per gal.)	
	Granite per M lots of 50,000 4x4x8 in.	Brick per M 3x4x8½ in. carload lots	Wood per sq. yd. 3½ in. 16-lb. treat	Tank car	Drums	Tank car	Drums	Tank car	Drums	Tank car	Tank car	Drums
Atlanta	$73.00	$39.35	$2.25	$18.53*e*	.....†	$0.0740*e*	.....†	$0.0806*he*	.....†	$0.0781*e*	$0.0806	.....†
Baltimore	150.00‡	49.00	85.00*m*	15.00*r*	21.00*r*	.06*r*	.09*r*	13.00*r*	23.00*r*	.06*r*	.07*r*	.14*r*
Birmingham	150.00	32.00*j*	.....	17.95	.....†	.0747	.....†	.0834*h*	.....†	.065	.095	.....†
Boston	85.00	59.00	3.75	15.00	24.00	.0625	.115	17.00	30.00	.0625	.0825	.145
Chicago	150.00	55.00	2.50/2.80*d*	14.00	22.50	13.00*g*	21.50*g*	.0575*h*	.15*h*	.05*n*	.09/.10*n*	.13/.15*n*
Cincinnati	120.00	55.75	.....	17.00	.....	.085	.....	12.25	.....	.07	.085	.....
Cleveland	120.00	34.00	3.77	17.00	19.00	.085	.095	.10*h*	.11	.08	.10	.....
Dallas	.....	36.00	.....	13.65	20.30	.06	.11	16.00	24.80	.06	.05/.07	.07/.09
Denver	.....	16.11	.....	11.00	.....	10.00	.....	.045*h*	.....	.....	.....	.....
Detroit	.....	37.00	.....	18.06*f*	25.60*f*	.0734	.128	.0718*h*	.119*h*	.067	.0775	.1149
Kansas City	.....	44.00	.....	18.50	23.50	.077	.1075	.077*h*	.107*h*	.057	.11	.15
Los Angeles	.....	50.00	.....	9.00*b*	23.00	9.50*bg*	24.00*bg*	9.50*b*	.....	.025	.072	.15
Minneapolis	.....	.....	2.017*d*	.....	27.70	.....	.126	.....	32.64	.....	.....	.....
Montreal	70.00	.....	.....	16.60*k*	24.25*k*	.116*k*	.1485*k*	.115*hk*	.135*hk*	.08*k*	.135*k*	.188*k*
New Orleans	.....	.....	.....	13.50*a*	20.00*a*	.057	.088	.06*h*	.095*h*	.....	.080	.....
New York	.....	65.00	.....	17.40	24.20*p*	14.00	.....	.0725*h*	.1325*hp*	.....	.0725*p*	.119*p*
Philadelphia	150.00	62.00	4.06	15.00*r*	.....	14.00/15.00	.....	.0625*h*	.....	.....	14.00*gr*	.....
Pittsburgh	135.00	39.75	.....	18.00	23.00	.09	.16	20.00	36.00	.07	.06	.11
St. Louis	.....	39.00	.....	16.00	22.00	15.00*g*	21.00*g*	.0575*h*	.12125*h*	.648	.06	.11
San Francisco	.....	45.00	.....	10.90	21.15	10.90*g*	18.00*gr*	12.90	17.50*r*	9.50*gr*	.0525	.1125
Seattle	.....	.....	.....	10.90*i*	21.90*i*	.....	20.40*gi*	11.40*i*	.....	10.90	.0525*i*	.0625*i*

‡ Delivered. *a* F.o.b. Baton Rouge. *b* Delivered to purchaser's warehouse. *c* 3½ x 4 x 8½ in. *d* 2-in. interior block, 6-lb. treatment. *e* Local reduction due to 20% reduction intra-state class freight rates, only Georgia affected. *f* Mexican. *g* Per ton. *h* Per gallon. *i* F.o.b. Martinez. *j* 3 x 3½ x 8½ in. *k* Tax included. *l* F.o.b. Toledo. *m* Per thousand. † Available on priority only and quoted specially. *p* No steel drum shipments except to armed forces. *r* February 1943 prices, none later available.

Trailer built by Rogers Bros. Corp.

$12,000 worth of tires for one 30-mile trip

A typical example of B. F. Goodrich development in tires

ARMY engineers wanted a secret load moved to the middle of a western desert. It weighed 230 tons. Time was all-important. How to get it there? Build a railroad? That was costly and slow. Move it by truck? No truck or trailer ever built would carry this load.

It was decided to design and build a huge trailer — if tires could be found to carry the load. And the trailer had to be built in 30 days. Engineers came to B. F. Goodrich with their tire problem — found just what they were looking for. B. F. Goodrich built special truck tires based on the desert tire principle developed previously by the company. These are wide-bottomed tires that don't sink into soft sand. Tires that can carry a terrific load.

Sixty-four big B. F. Goodrich tires, each weighing 220 pounds, were mounted on the trailer — eight rows of tires, eight in each row. The trailer was more than 39 feet long, nearly 17 feet wide, and weighed 73 tons. It was built to carry a total load of 300 tons — the heaviest load ever hauled on pneumatic tires.

Army tanks pushed and pulled the loaded trailer from the railroad siding to the desert. The load arrived safely and on schedule. Twelve thousand dollars' worth of tires, still usable but made primarily for this one trip that may have shortened the war.

This example of B. F. Goodrich ability to meet an unusual transportation problem is typical of the research and development carried on constantly by the company. Research which means better tires for trucks, cars, airplanes, farm vehicles, and industrial equipment. *The B. F. Goodrich Co., Akron, O.*

Truck Tires BY

B.F. Goodrich

IRON AND STEEL PRODUCTS—BASE MILL PRICES

	STRUCT. SHAPES-PLATE	REINF. BARS ¾-in. billet *b*	RIVETS ½-in. structural	WIRE NAILS Base *d*	SHEET PILING Base	STEEL RAILS Per Gross Ton: Standard	Light	Re-rolled	TRACK SUPPLIES: Angle Bars	Std Spikes *c*	Tie Plates *c*	Track Bolts
Birmingham	$2.10	$2.15	$3.75	$2.90	....	$43.00	$45.00	$45.00*	$2.70	$3.25	$2.30	$4.75
Chicago	2.10	2.15	3.75	2.90	$2.40	43.00	45.00	45.00*	2.70	3.25	2.30	4.75
Pittsburgh	2.10	2.15	3.75	2.90	2.40	43.00	45.00	45.00*	2.70	3.25	2.30	4.75
Buffalo	2.10	2.15	....	....	2.40	.....	.....	.....	....	....	2.30	....
Cleveland	2.10	2.15	3.75	2.90	....	.....	.....	.....	....	....	....	....
Youngstown	....	2.15	....	....	....	.....	.....	.....	....	3.25	....	....
Detroit	....	2.27‡	....	....	....	.....	.....	.....	....	....	....	....
Gulf ports	2.47*a*	2.52*a*	....	....	2.85*a*	.....	.....	.....	....	....	....	....
Pacific ports	2.75*a*	2.80*a*	....	3.40	2.95*a*	.....	.....	.....	....	....	....	....

‡ Delivered. *a* F.o.b. cars dock. *b* Rail steel same as billet prices. *c* Other spikes alone, Lebanon, Pa., Richmond, Va. *d* Add switching charge $18 per ton. basing points include Portsmouth, O., Weirton, W. Va., St. Louis, Kansas City, Minnequa, Colo., and Pacific coast ports, on tie plates alone, Steelton, Pa., on * Per net ton.

IRON AND STEEL PRODUCTS—F. O. B. WAREHOUSE, PER 100 LBS., BASE PRICE

	STRUCTURAL SHAPES Per 100 lb. base price	REINFORCING BARS* Per 100 lb., ¾ in., base price: 15 tons or over *b* New billet	Rail steel	Add Switch	Add $/cwt. for Del.	EXPANDED METAL LATH Per 100 sq. yd., carload lots: Std. diamond mesh, 3.4 lb.	Std. ribbed 3.4 lb.	WELDED FABRIC REINFORCING Per 100 sq. ft., carload lots: 4x16 in., No. 5 & 10 wires	4x12 in., No. 8 & 12 wires	6x6 in. No. 6 & 6 wires *k* Per 100 s. f.	SHEET PILING Per 100 lb. base price
Atlanta	$2.34	$2.40	$2.40	$.02½	$.10	$21.06	$23.00	$1.82	$1.35	$1.91	$3.04
Baltimore	3.70	2.90	2.75	....	.10	23.00	25.00	1.70	1.27	1.79	3.00
Birmingham	2.10*c*	2.15	2.15	.02½	.10	19.00	21.00	1.80	1.34	1.89	....
Boston	3.912	3.994	....	$20 C.L.	.10	18.50	29.50	1.76	1.31	1.84	2.77
Chicago	2.10*c*	2.15*a*	2.15*a*	.03	.05	21.50	23.50	1.67	1.25	1.75	2.40
Cincinnati	3.68	2.53*cd*	2.53*cd*	....	.05	19.50	21.50	1.66	1.25	1.74	....
Cleveland	3.588*k*	3.10*k*	3.10*k*	.02½	.10	20.50	22.50	1.66	1.25	1.74	....
Dallas	4.25	3.17	3.17	....	....	25.50	27.50	1.93	1.42	2.03	....
Denver	4.57	4.09	....	....	....	26.50	26.50	1.97	1.45	2.07	....
Detroit	3.661‡	2.50‡	2.50‡	....	.10	30.00	30.00	1.68	1.26	1.76	2.66
Kansas City	4.19	2.61*cd*	2.61*cd*	.0	.05	24.50	26.50	1.78	1.33	1.87	2.874
Los Angeles	3.65*f*	2.575	2.425	.02½	.05	23.00	27.50	1.93	1.42	2.03	3.65
Minneapolis	3.81‡	2.79	2.79	.0	.10	21.00	23.00	1.80	1.34	1.89	2.79*i*
Montreal	3.95*i*	2.90*i*	2.80*i*	....	....	31.00*hi*	46.00*hi*	2.76	3.44*i*	2.82*im*	....
New Orleans	4.158‡*k*	3.59*k*	....	.05	.10	23.50	22.00	1.82	1.35	1.91	2.875
New York	3.75	2.76*c*	2.76*c*	....	.15	17.50	19.50	1.76	1.32	1.81	2.74
Philadelphia	3.666	3.668	....	....	....	20.50	22.50	1.71	1.28	1.79	2.72
Pittsburgh	2.10*a*	2.15*a*	2.15*a*	.02½	.10	23.00	26.50	1.59	1.20	1.67	2.40
St. Louis	3.697	2.74	2.74	.0	.05	28.00	34.00	1.69	1.27	1.78	2.70
San Francisco	4.35	2.825	2.675	.02½	.10	21.00	24.50	1.93	1.42	2.03	3.70
Seattle	2.75*e*	2.80*e*	....	....	....	34.50	38.50	1.93	1.42	2.03	2.95*e*

‡ Delivered. *a* Mill prices. *b* 5–15 tons, add 15c. 1–5 tons, add 25c. Less than 1 ton, add 50c. *c* 20 tons or over Base. *d* Mill price plus freight. *e* F.o.b. dock. *f* Includes delivery in free delivery zone. *g* Less than 1 ton, add 25c.; 1 to 5 tons, add 10c. * High scrap steel prices cut former 15c. differences between new billet and rail steel in many mills. *h* List price. *i* Plus Dominion and Province sales tax. *k* Quotation on changed basis; no actual price change. *m* Per sq. yd.

PLUMBING, HEATING, WATER, SEWER AND DRAIN PIPE

	C. I. PIPE Per net ton f.o.b. 6 in. to 24 in. *a*	VITRIFIED SEWER PIPE: Per foot, std. 8 in., s.s.	Delivered std. 12 in., s.s.	ASTM 24 in.	C13-35 36 in.	CLAY DRAIN TILE Per 1,000 ft., carload lots, f.o.b.: 6 in.	8 in.	CONCRETE SEWER PIPE Per ft., delivered; ASTM C 14-35: 12 in.	24 in.	WROUGHT STEEL PIPE Full standard weight, *h*: 1 to 3 in., Butt Weld: Black %	Galv. %	3½ to 6 in.; Lap Weld: Black %	Galv. %
Atlanta	$51.66	$0.43*b*	$0.67	$3.39	$5.70*c*	$110.00	$140.00	$0.45	$2.00	48.2	54.2	59.7	51.2
Baltimore	55.00	.35	.60	2.70	7.25	160.00	200.00	.75	2.00	65.5	57.5	63.0	54.5
Birmingham	47.00	.275	.495	1.95	5.50	100.00	220.00	.50	1.70	62.2	54.2	59.7	51.2
Boston	57.40	.371*r*	.7155*r*	2.79*r*	7.6875*r*	170.00‡*r*	265.00‡*r*	.46*t*	1.77*t*	....	....	....	....
Chicago	56.33	.40	.675	2.70	7.00	100.00‡	150.00‡	.45	1.85	66.0	55.0	64.5	53.0
Cincinnati	55.27	.231	.4455	1.80	5.125	105.00‡*s*	170.00‡*s*	.75	1.75	57.1	43.4	54.0	39.6
Cleveland	56.75	.266*r*	.513	2.15	5.535	90.60	139.40	.36	1.60	68.5	57.5	66.0	54.5
Dallas	58.43	.31	.58	2.25	5.00	90.00	110.00	.46	1.57	....	....	....	....
Denver	63.56	.32‡	.576‡	2.376‡	....	143.00‡	264.00†	1.00†	2.05†	58.4	50.4	55.7	47.2
Detroit	56.75	.385	.7425	2.925	7.75	170.00‡*u*	263.00‡*u*	.36	1.75	57.6	44.0	54.5	40.2
Kansas City	57.73	.31	.56	2.20	6.20	154.00	286.00	.45	1.60	35.6	46.1	46.2	59.4
Los Angeles	70.40	.325†	.585†	2.70†	6.75†	130.50	217.50	1.00	2.00	61.1	50.1	58.6	47.1
Minneapolis	59.83	.305†	.549†	2.196†	6.25†	....	....	.90	2.10	64.2	53.2	60.7	49.2
Montreal	67.00	.85*o*	1.50*o*	5.25*p*	8.50*ep*	45.00*m*	64.00*m*	.811*m*	2.31*m*	....	....	....	....
New Orleans	53.78	.37*r*	.78	1.69	....	150.00	220.00	.45	1.65	62.4	54.4	58.8	50.3
New York	54.40	.38	.75	3.06	7.33	....	....	.60	1.40	64.9	53.9	62.4	50.9
Philadelphia	53.00	.35	.675	2.835	7.35	165.00	225.00	.45	1.75	56.6	42.8	53.6	39.1
Pittsburgh	58.00	.266†	.513†	2.295†	5.945	97.80	154.20	.85*g*	2.00*g*	68.5*i*	57.5*i*	66.0*i*	54.5*i*
St. Louis	54.84	.31	.558	2.232	4.95	93.50	242.00	1.00*j*	2.15*k*	68.5	57.5	66.0	54.5
San Francisco	70.40	.3625*d*	.6525*d*	2.61	6.52	115.00	192.50	.58	2.34	45.0	31.0	41.0	26.0
Seattle	72.20	.40	.72	2.88	....	115.20	.....	.51*f*	1.44*f*	....	....	....	....

‡ Delivered. † F.o.b. *a* B. & S. class B and heavier, C/L lots, 200 tons and over Burlington, N. J. (base) $50.00. Based on existing freight rates; subject to rate change. Gas pipe and class A. $3 per ton additional, 4 in., $3 per ton additional, 30 in. and larger usually $2 per ton less. *b* Double strength. *c* List to dealer. *d* List. *e* 30-inch. *f* Less 5% for cash. *g* Culvert pipe. *h* Discounts from standard list consumers carload prices, except Pittsburgh prices are f.o.b. mill. Base price $200 per net ton. List prices per ft.; ¾ in., 8½c.; 1 in., 11½c.; 1 in., 17c.; 2 in., 37c.; 2½ in., 58½c.; 3 in., 76½c.; 4 in., $1.09; 6 in., $1.92; 3 per cent tax on transportation costs not included. *i* Applies also at Lorain, Ohio mills. Chicago delivered base is 2½ points less on butt, 1½ on lap. Freight is figured from Pittsburgh. Lorain, O., Chicago Dist. Billing is from point producing lowest price at destination. WROUGHT IRON PIPE: Base price and list prices per ft. same as wrought steel pipe. Discount for Pittsburgh base. Butt-weld—1 in. and 1¼ in. black 34 galv. 16; 1½ in. black 38 galv. 18½; 2 in. black 37½, galv. 18. Lapweld—2½ in. to 3½ in. black 31½ galv. 14½; 4½ in. to 8 in black, 32½ galv. 17. Reinforced; spec. C 76–37. *k* Reinforced; spec C 75–37. *l* Plus sales tax. *m* Centri. spun. *n* 27-in. pipe. *o* Less 50%. *p* Less 53%. *s* Price quotations on delivered basis since Mar. 1940; current f.o.b. price $84 for 6 in.; $130 for 8 in. *t* Full truck load lots. *u* Scarce: carload quantities not readily available.

P&H's Added Values

mean *Added Profits* for you!

When you own a P&H, you're in a stronger competitive position to get business—to earn more profit. For P&H builds to quality standards far beyond those of the industry. P&H's added values make your investment a better investment for years to come.

HYDRAULIC CONTROL—smoother, faster, easier operation than you've known in an excavator.

PLANETARY TRANSMISSION—faster, more accurate crowd controls—far lower maintenance costs.

BETTER STEERING—you can turn right or left abruptly or make a complete circle without stopping.

TRACTOR TYPE CRAWLERS—save hundreds of dollars each year in trouble-free travel.

ALL WELDED CONSTRUCTION—rolled alloy steels provide greater strength, greater rigidity—longer life throughout.

These are but a few of P&H's added values. Ask about the rest.

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P&H EXCAVATORS
4404 W. National Avenue
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HARNISCHFEGER CORPORATION
EXCAVATORS · ELECTRIC CRANES · ARC WELDERS · P&H · HOISTS · WELDING ELECTRODES · MOTORS

LUMBER, TIMBER PLYWOOD—PER M FT., B.M., CARLOAD LOTS F.O.B.

	SHORT LEAF YELLOW PINE AND DOUGLAS FIR — All S. L. Y. P. is No. 2 common or better and for No. 1 N. C. Box. (Prices in Bold Face) — All Fir planks No.2 common, Fir timber is No. 1 common. Lengths up to 20 ft. (Prices in italics)									LONG LEAF Y. P. Merchantable grade up to 20 ft.		PLYWOOD Rail freight increment (See note for base price)	
	1x6 S4S	1x8 S4S	2x4 S4S	2x6 S4S	2x8 S4S	2x10 S4S	3x12 R.L.	6x12 R.L.	12x12 R.L.	2x12 R.L.	12x12 R.L.	3/8"	3/4"
Atlanta	$41.00	$41.00	$35.50	$38.50	$37.50	$41.50	$45.00	.....	.....	$60.50	$64.00	$17.90	$21.85
Baltimore	44.00	46.00	44.00	46.00	47.00	52.00	65.00	.....	.....	115.00	120.00	18.25	22.25
	48.00	*49.00*	*55.00*	*55.00*	*55.00*	*57.50*	*68.00*	*$75.00*	*$75.00*	.....	.....	.....	.....
Birmingham	45.00	45.00	44.50	43.50	44.50	47.50	68.00	55.00	56.00	.....	.....	17.35	21.15
[1]	50.00	50.00	49.50	48.50	49.50	52.50	72.00	.....	.....	67.50	70.00	.....	.....
Boston	60.00[g]	60.00[g]	60.00[g]	60.00[g]	60.00[g]	62.00[g]	66.00[g]	.....	.....	58.00[g]	58.00	18.25	22.25
	55.00	*55.00*	*54.00*	*54.00*	*54.00*	*54.00*	*58.00*	*58.00*	*58.00*	.....	.....	.....	.....
Chicago	58.00	59.00	58.50	55.00	54.00	62.00	68.00	.....	.....	90.00[l]	95.00[l]	14.60	17.80
	53.00	*53.00*	*54.00*	*55.00*	*54.00*	*55.00*	*66.00*	*56.00*	*57.00*	.....	.....	.....	.....
Cincinnati	47.50	49.00	42.50	42.50	42.50	44.50	67.00	.....	.....	65.00	65.00	17.35	21.15
	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
Cleveland	42.50[k]	42.50[k]	52.50[k]	51.00[k]	65.00	65.00	83.00	83.00	83.00	.....	.....	17.75	21.60
Dallas[e]	45.25	45.25	44.50	43.00	43.00	47.25	60.75	58.75	58.75	88.75	85.00	14.60	17.80
Denver[‡]	64.25[4]	64.25[4]	64.75[4]	65.25[4]	63.75[4]	64.75[4]	68.75[4]	*72.00*	*72.25*	.....	.....	10.45	12.70
Detroit	61.00	61.00	57.75	57.75	57.75	63.75	71.00	.....	.....	70.75	90.00	17.35	21.15
	57.00	*57.00*	*57.00*	*57.00*	*62.75*	*72.75*	*75.00*	*75.00*	*90.00*	.....	.....	.....	.....
Kansas City[a]	69.00	69.00	67.00	65.50	67.00	69.00	84.00	.....	.....	84.00	94.00	12.60	15.40
	66.00	*66.00*	*59.50*	*59.50*	*59.50*	*59.50*	*75.00*	*80.00*	*80.00*	.....	.....	.....	.....
Los Angeles[a]	*60.00*	*60.00*	*60.50*	*60.75*	*59.25*	*59.25*	*72.75*	*72.00*	*72.00*	.....	.....	*9.90[gh]*	*12.05[gh]*
Minneapolis[‡b]	63.00[g]	62.00[g]	.....	.....	.....	.....	.....	.....	.....	.....	.....	12.60	15.40
[‡]	*63.00*	*63.00*	*60.00*	*61.00*	*59.00*	*60.00*	*61.00*	*65.00*	*65.00*	.....	.....	.....	.....
Montreal[†7]	*64.00*	*65.00*	*60.00*	*63.00*	*65.00*	*70.00*	.....	.....	.....	200.00	200.00	.....	.....
	90.00	*90.00*	*90.00*	*90.00*	*90.00*	*90.00*	*80.00*	*80.00*	*80.00*	.....	.....	.....	.....
New Orleans	42.00	42.00	39.00	38.50	34.00	42.00	46.00	.....	.....	54.50	69.00	14.60	17.80
	30.50	*30.50*	*30.00*	*30.00*	*29.00*	*29.00*	*28.50*	*29.50*	*29.50*	.....	.....	.....	.....
New York	67.50	67.50	62.50	62.50	62.50	64.00	74.00	.....	.....	120.00[f]	125.00[f]	18.35	22.25
[‡]	.....	.....	*65.00[i]*	*65.00[i]*	*65.00[i]*	*65.00[i]*	[Range from $75 to $95]			.....	.....	.....	.....
Philadelphia	75.00	75.00	75.00	75.00	75.00	75.00	75.00	.....	.....	130.00	130.00	18.25	22.25
	75.00	*75.00*	*75.00*	*75.00*	*75.00*	*75.00*	*85.00*	*90.00*	*90.00*	.....	.....	.....	.....
Pittsburgh	50.80	53.20	62.75	55.00	60.85	62.50	76.25	.....	.....	.....	.....	18.10	22.05
	69.20	*69.10*	*66.10*	*65.30*	*65.20*	*65.65*	*82.75*	*88.75*	*88.75*	.....	.....	.....	.....
St. Louis[‡c]	61.00	61.00	57.00	56.00	57.00	59.00	71.00	*75.00*	*75.00*	87.00	87.00	14.60	17.80
San Francisco[d]	*41.00*	*41.00*	*36.50*	*36.75*	*35.75*	*35.75*	*37.50*	*38.00*	*36.00*	.....	.....	*7.30[g]*	*8.90[g]*
Seattle	*45.50*	*45.50*	*45.75*	*45.75*	*44.50*	*44.50*	*47.75*	*47.75*	*46.50*	.....	.....	0.00	0.00

Bold Face type, Southern Pine. *Italics, Douglas Fir.* [1] Long leaf. [2] Roofers N. C. Pine. [3] Spruce. [4] Native. [6] Western Pine, No. 3 Common. [7] Spruce. [8] Norway Pine. ‡ Delivered. *a* Yard prices. *b* Contractors discount in Minneapolis and St. Paul discontinued May 21, 1938. *c* 5M ft. or less. *d* F.o.b. cars San Francisco freight rate. *e* 10% discount taken off. *f* Up to 18 ft. † Plus sales tax.

Note: Special concrete form grade Fir Plywood, 4' by 8' panels, 5-ply, sanded 2 sides, water resistant glue, carload lots, delivered per 1,000 sq. ft. surface. Seattle base price on ⅜", $95.15; on ¾", $104.85; price includes oiling and sealing charges. For other centers add rail freight increment from table or proper size. For resin dipped treatment, add $10.50 per M. *g* Lower rate by water shipment. *h* 50,000 lb. minimum. *i* Ranges from $65 to $75. *j* Average price. *k* August 1943 price. *l* September price; none later available.

GLASS, EXPLOSIVES, CHEMICALS

	WINDOW GLASS — Discounts from jobbers list, Aug. 15, 1938 Single or Double Thickness		EXPLOSIVES — Per lb. 40% Ammonia Gelatin in 50-lb. cases delivered in 200 lb. lots*	
	A quality	B quality		
Atlanta	74%	75%	$0.15	
Baltimore	78%	79%	.15	
Birmingham	76%	76%	.105	
Boston	77%	78%	.15	
Chicago	77%	77%	.15	
Cincinnati	77-10%	77-10%	.15	
Cleveland	77%	77%	.19	
Dallas	76%	76%	.1625	
Denver	76%	76%	.155*e*	
Detroit	77%	77%	.1575	
Kansas City	77-10%	77-10%	.155	
Los Angeles	86%*d*	88%*d*	.1575	
Minneapolis	77%	77%	.155	
Montreal	40-10-2%*ab*	50-2%*ac*	.1675†	
New Orleans	70%	75%	.16	
New York	80%	81%	.22*f*	
Philadelphia	78%	79%	.15	
Pittsburgh	79%	79%	.1225	
St. Louis	77-10%	77-10%	.155	
San Francisco	66%	73%	.155	
Seattle	75%	75%	.1575†	

Price of 60% Ammonia Gelatin in $0.01 per lb. higher than 40%

a Discount from list Sept. 1939; sales tax included, but 6% tax exemption not allowed for. *b* Single thickness. *c* Double thickness. *d* Discount from jobbers' list Sept. 15, 1928.

* Urban prices influenced by service charges or local storage and delivery regulations, do not consistently reflect quantity prices in less congested areas *e* F.o.b. Louviers, Colo. *f* In boroughs of Kings, Queens and Richmond, and in Manhattan south of Canal St. add delivery charge of $6.00 per trip. [1] F.o.b.

40% Ammonia Gelatin price ranges in other than urban areas, per lb. (except Seismograph Grades)

	C/L 20,000 lb. net	Tons	200 lb. lots
E. of the Miss., except Fla. and Me.	$0.105	$0.13	$0.15
W. of Miss. to Rocky Mtn. States, Fla. and Maine.	.11 -.1175	.135 -.1175	.155 -.1675
Rocky Mtn. States	.11 -.1225	.135 -.1525‡	.155 -.1725‡
Pacific N. W. States	.1075-.12	.1375-.15	.1575-.17
Pacific S. W. States	.1050-.1125	.135 -.1425	.155 -.1625

‡ F.o.b. Louviers, Colo., or Butte, Mont.

PILES, TIES F.O.B.

PILES

Prices per linear foot, fir and pine, bark on, f.o.b. cars, New York. Fir based on Wash. and Ore. points to New York shipping area; pine based on freight from Norfolk.

Dimensions	Points	Length	By Rail — Pine *	Fir
12-in. at butt	6-in.	30 to 50-ft.	$0.34	.....
12 in.— 2 ft. from butt	6-in.	50 to 59-ft.	.35	.....
12-in.— 2 ft. from butt	6-in.	60 to 69-ft.	.36	.....
12-in.— 2 ft. from butt	6-in.	90 to 100-ft.	...	.5325
13-in.— 3-ft. from butt	5-in.	91 to 100-ft.	...	.5725
14-in.— 2-ft. from butt	6-in.	50 to 69-ft.	.41	.6275
14-in.— 2-ft. from butt	6-in.	70 to 79-ft.	.43	.57
14-in.— 2-ft. from butt	5-in.	80 to 85-ft.	.54	.....
14-in.— 2-ft. from butt	5-in.	85 to 89-ft.	.57	.....
14-in.— 2-ft. from butt	5-in.	90 to 100-ft.	...	.62

* Pine piling over 80-ft. available only in limited quantities.

RAILWAY TIES

Prices f.o.b. per tie for carload lots:		6"x8"x8' Untr.	6"x8"x8' Tr.	7"x9"x8'6" Untr.	7"x9"x8'6" Tr.
Boston	Oak	$1.50	....	$2.00	....
	Pine	2.00	$3.00*a*	2.50	$3.00*a*
New York	S. L. Sap Pine	1.43/1.54	2.59	1.76	2.86
	Mixed Oak	1.71	2.59	2.42	3.58
Birmingham	White Oak	1.00	1.60*a*	....	2.25*a*
Chicago	Red Oak	....	2.45/2.65*a*	....	3.35/3.60
Los Angeles	Douglas Fir	2.00	3.25*a*	2.90	4.70*a*
Philadelphia	Red Oak	....	2.10*ag*	....	3.25*ag*
St. Louis	White Oak	1.60	....	2.19	....
	Red Oak	1.63	2.15*a*	2.19	3.25*a*
	Sap Pine or Cypress	1.70	....	2.06	....
San Francisco	Douglas Fir	1.25*bef*	....	....	3.00*eaf*
Montreal	Birch or Maple	....	1.65	1.05	....

Tr.— Treated; Untr.— Untreated. *a* Creosoted. *b* 6"x8"x8'6". *c* Empty cell. *d* Zinc. *e* Green. *f* F.o.b. cars. † Out of market. *g* January 1943 price, none later available.

CHEMICALS

Water, sewage treatment, road work, f.o.b. carlots, New York

Bleaching powder, in drums, f o.b. works, per 100-lb	$2.50- 3.10
Chlorine cylinders, liquid, per lb., delivered	.0525
Calcium chloride, 77-80%, flaked, 100-lb. paper bag, del'd, ton	18.50-35.00
Silicate of soda, 52 deg. in drums, f o.b. works, per 100 lb	1.40
Soda ash, 58%, in paper bags, per 100 lb. dense	1.15
Sulphate of aluminum, commercial, in 100-lb. bags, per ton	23.00-25.00
Sulphate of copper, in bbl., per 100-lb	5.00

The men behind the DRILLS Prefer

Photograph courtesy Miami Copper Company, Miami, Arizona.

Drillers who are fortunate enough to have the advantage of Timken Removable Rock Bits—and that goes for a very large and constantly increasing number—are enthusiastic about them. They have found they can drill more holes per shift with much less effort and trouble than they ever were able to do with conventional steels.

This is reflected in lowered costs for the mine operators due to saving in steel; virtual elimination of tramming; conservation of man hours.

Three factors enter into the superiority of Timken Bits. One is design—including thread and shoulder construction; the second is material—Timken Steel produced in our own steel plant; the third comprises care and accuracy of manufacture—Timken Bits are produced by specialists in a plant devoted exclusively to bit manufacture and equipped with the most modern machines and appliances for this purpose.

Now is the time to check into your drilling costs and to begin to reduce them by the adoption of Timken Bits — if you have not already done so. The Timken Roller Bearing Company, Canton 6, Ohio.

STRUCTURAL CLAY BUILDING TITLE, BRICK AND LIME—DELIVERED

	STRUCTURAL CLAY TILE PARTITION — SCORED Per M lots of 2,000 pieces or over,			STRUCTURAL CLAY TILE — LOAD BEARING — SCORED Per M lots of 2,000 pieces or over			BRICK Per M in quantity		LIME		
	3x12x12 in.	4x12x12 in.	8x12x12 in.	8x12x12 in.	10x12x12 in.	12x12x12 in.	Common backing	Straight hard	Per ton, Hydrated finishing	In paper, Common hydrated	Carload lots, Pulverized or lump
Atlanta	$110.00	$130.00	$230.00	$240.00	$270.00	$300.00	$18.25	$24.00	$17.50	$13.50	$15.04
Baltimore	84.00	90.00	170.00	200.00	260.00	300.00	17.00*k*	21.00*k*	19.00	14.00	2.50*m*
Birmingham	80.00	85.00	160.00	191.00	252.00	288.00	16.50	23.00	18.11	13.64	2.25*m*
Boston	103.75*a*	110.65*a*	207.45*a*	248.90	.....	.....	20.00*i*	20.00*i*	21.00†	.....	16.00
Chicago	85.80	91.70	172.60	.....*x*	.....*x*	.....*x*	17.00	18.00	17.00	15.00	12.50
Cincinnati	65.55	69.90	131.20	148.70	210.35	240.45	27.75	27.75	15.50	13.00	.....
Cleveland	97.50	104.00	.....*x*	.....	.....	.....	22.75	22.75	15.75	13.25	.....
Dallas	71.40	76.40	145.30	183.50	278.00	294.50	15.25*i*	16.75*i*	19.00	15.00	15.00
Denver	99.00	112.00	185.00	214.00	248.00	294.00	21.50	21.50	25.00*j*	17.00*j*	20.00*j*
Detroit	92.70	96.70	174.50	198.80	257.20	294.30	23.25	23.25	18.00	16.00	16.00
Kansas City	67.00	69.00	89.00*c*	128.00	163.00	189.00	17.50	18.50	19.32	13.00	10.92
Los Angeles	73.50†*r*	89.50†*r*	128.00*c*†*r*	210.00†*r*	368.00†*r*	460.00†*r*	13.50	15.00	16.50	17.50	17.50
Minneapolis	.....	111.60*b*	186.25*b*	.....	189.00*b*	262.00*b*	25.50	31.50*g*	24.00	16.00	19.00
Montreal	92.50*a*	98.50*a*	196.25*a*	151.50*a*	100.50*at*	134.50*av*	22.16†*u*	33.20†*u*	24.60*u*	15.00*u*	14.00*u*
New Orleans	72.00	72.00	135.00	162.00	210.00	260.00	14.00	.....	18.30	12.08	14.10
New York	99.40	106.00	145.75*c*	235.00*h*	287.40*h*	355.80*h*	19.50/20.50	.....	20.00	14.00	17.00
Philadelphia	112.10	119.60	224.20	269.10	321.20	405.10	20.75	23.75	19.00	16.00	15.00
Pittsburgh	87.20	91.20	169.80	252.00	284.00	325.00	23.25	25.25	17.90	15.40	2.55*m*
St Louis	67.00	72.00	130.00	190.00	244.00	290.00†	22.50	21.50	22.00	18.00	2.50*m*
San Francisco	96.00	108.00	144.00	108.00*t*	.....	.....	22.50	.....	24.00	23.00	2.50*m*
Seattle	115.00	125.00	230.00	.....	.....	.....	20.50*f*	24.00*f*	20.00*s*	20.00*s*	3.00*m*

† F.o.b. *a* Smooth. *b* Carload lots delivered to job. *c* 6x12x12 in., 3-cell. *d* Not load bearing. *e* 48 lb. tile. *g* Selected common. *h* F.o.b. Perth Amboy, N. J. *i* F.o.b. Warehouse only. *f* LCL. *k* $1.00 discount if paid in 10 days. *l* Lump. *m* Per bbl., 180 lb. *o* Per bbl., 200 lb. *p* 280 lb. bag. *r* 5% discount 10 days. *s* 2% discount for cash. *t* 5½x8x12. *u* 8% sales tax included. *v* 6x12x12-in. *w* Per 200 lb. bag. *x* Not available.

PAINT, ROOFING—F.O.B. CARLOAD LOTS

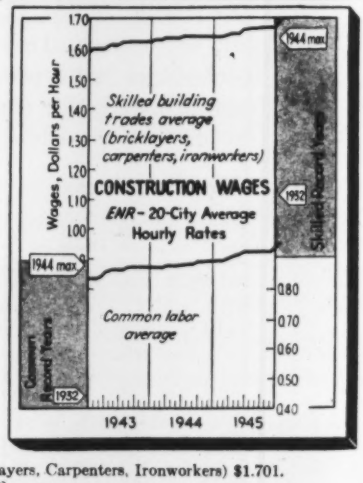
	RED LEAD Per 100 lb. in 600-lb. (Approx.) bbl.	WHITE LEAD Per 100 lb.	READY-MIXED PAINT Per gal., drums			ROOFING SUPPLIES Carload lots f.o.b., factory				
	Dry *a*	in oil	Graphite *b*	Aluminum *b*	Ferric Oxide *d*	Rolls, slate surfaced, 85–90 lb. per sq.	Asphalt felt, per 100 lb.	Tar felt, per 100 lb.	Asphalt coating per gal.	Tar pitch 350 lb. bbl. per ton
Atlanta	$10.25	$14.125	$1.30	$2.25	$1.20	$2.06	$2.06	$2.06	$1.00	$36.00
Baltimore	10.00	13.75	2.00	3.00	2.50	2.30	2.70	2.70	.40	29.00
Birmingham	10.25	14.125	2.35	3.50*r*	1.98*r*	2.09	1.98	1.98	.32	28.35
Boston	10.00	13.75	1.75	2.50	2.31	2.00‡*h*	3.30‡*uv*	3.30‡*uv*	.25‡	21.00‡
Chicago	10.00	13.75	....	....	....	1.75*hf*	1.74*hf*	1.82*hf*	.33*f*	23.00*f*
Cincinnati	10.00	13.75	1.70	2.90	1.60	2.20	2.10*h*	2.10*h*	.33	25.00
Cleveland	10.00	13.75	1.70	2.90	1.60	1.71	1.63*h*	1.61*h*	.237	25.00
Dallas	10.00	14.50	1.88	2.11*n*	.05*l*	1.75*h*	1.66*h*	1.66*h*	.35	39.00
Denver	10.00	14.25	....	....	.27*l*	2.45	2.95	2.95	.35	28.00
Detroit	10.00	13.75	1.75	3.00	1.60	2.25	2.25	2.25	.50	23.00
Kansas City	10.00	13.875	2.30*g*	2.55*gr*	2.16*g*	2.19	2.30	2.30	.28	27.50
Los Angeles	10.25	14.25	1.60	2.25	2.30	2.10	1.50	....	.45	.....
Minneapolis	10.00	13.875	....	....	....	1.7123*i*	1.6243*hi*	1.6243*hi*	.32	23.00
Montreal	.....	11.05	2.50*p*	4.90*p*	3.15*p*	4.02*t*	2.58*t*	3.01*t*	.89*t*	2.10*kl*
New York	10.00	13.75	2.03	....*r*	1.82	1.7098	1.6273*a*	1.6273*o*	.26	23.00
Philadelphia	10.00	13.75	1.60/1.80	2.20*r*	1.55	2.25	2.71	2.71	.32	23.00
Pittsburgh	10.00	13.75	1.05	1.95	.80	1.95	1.84*h*	1.84*h*	.34	26.00
St. Louis	10.00	13.75	2.28*s*	2.89*s*	1.96*s*	1.77	1.77	1.77	.35	23.00
San Francisco	10.25	14.00	1.80	2.75*n*	1.35	1.71	2.40	2.40	.33	20.50
Seattle	10.25	14.25	1.90	3.00	....	2.15	2.16*h*	....	.35	26.50*j*

‡ Delivered. Note: Red lead in oil 50c. higher than white lead in oil. *a* Red lead prices change frequently due to pig lead price changes. *b* U. S. War Dept Spec. 3-49A. *c* ASTM Spec. D266-31. *d* 80% minimum ferric oxide. *e* Subject to 25% discount. *f* Distributors' price to contractors. *g* 5 gal. can. *h* Per roll, 65 lb. *i* Minneapolis and vicinity. *j* Asphalt pitch. *k* Per 100 lb. *l* Per lb. *m* Per bbl. *n* May, 1941 price. *o* 60-lb. roll. *p* Plus 8% sales tax. *r* Not available, except on priority rating; then quoted specially. *s* December, 1942 price. *t* Federal tax included. *u* 90-lb roll. *v* Truck delivery.

SKILLED AND COMMON WAGE RATES—PER HOUR

	Bricklayers	Carpenters	Struct. Iron Workers	Hoisting Engineers	Plasterers	Common Labor Building	Common Labor Heavy Const.
Atlanta	$1.50	$1.25	$1.50	$1.25	$1.50	$0.65	$0.65
Baltimore	1.75	1.675	1.90	1.625/1.80	1.725	.95	.95
Birmingham	1.75	1.375	1.625	1.50	1.65	.65	.65
Boston	1.725	1.60	1.725	1.50 /1.875	1.667	1.15	1.15
Chicago	1.90	1.85	1.88	1.85	1.90	1.20	1.20
Cincinnati	1.825	1.60	1.725	1.45 /1.60	1.75	.90	.90
Cleveland	1.875*c*	1.65	1.875	1.875	1.875	1.085	1.125/1.155
Dallas	1.625	1.25	1.50	1.75	1.625	.60	.75 /1.25
Denver	1.80*b*	1.625	1.50*b*	1.625*b*	1.65	1.00	1.00
Detroit	1.725	1.50	1.825	1.675/1.825	1.775	1.00	1.00
Kansas City	1.75	1.575	1.70	1.70	1.75	.975	.90
Los Angeles	1.50	1.35	1.625	1.375	1.667	1.00	1.00
Minneapolis	1.625	1.50	1.625	1.60	1.725	.95	.95
New Orleans	1.625	1.375	1.625	1.55	1.50	.70	.80
New York	2.25*b*	2.10*b*	2.55	2.25*b*	2.00*b*	1.20	1.20
Philadelphia	2.00	1.58	1.90/2.00	2.25	2.00	.90	.90
Pittsburgh	1.90	1.75	1.75	1.8125	1.875	1.00	.90
St. Louis	1.90	1.70	1.90	2.00	1.75	1.00	1.00
San Francisco	1.875	1.50	1.75	1.50/1.75	1.75	1.00	1.00
Seattle	1.845	1.545	1.745	2.00	1.845	1.145	1.145
Montreal*	1.06	.96	1.01	1.01	1.06	.61	.66

b 7 hr. day. *c* Prevailing rate on government work.
* Cost of living bonus now included in basic wage.



ENR Skilled Average; (Bricklayers, Carpenters, Ironworkers) $1.701.
ENR Common Average; $0.952.

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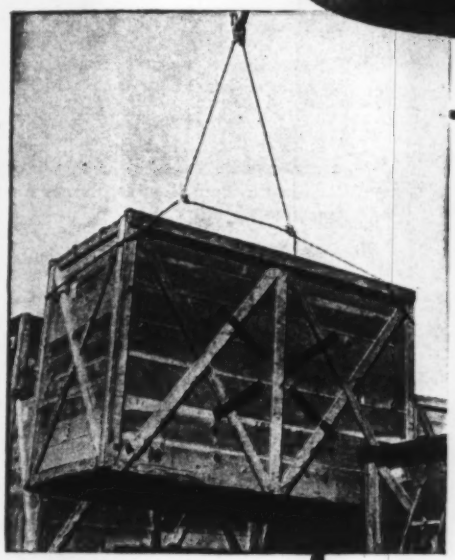

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(*Continued from page* 160)

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THE FINANCIAL RECORD OF THE ELECTRIC UTILITY INDUSTRY—1937-1944. 14 pp. Federal Power Commission, Washington, D. C.

A YEARBOOK OF RAILROAD INFORMATION—By Western Railways Public Relations Office. 1945 Edition. Eastern Railroad Presidents Conference Committee on Public Relations, 143 Liberty St., New York 6, N. Y.

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HEALTH PRACTICE INDICES 1943-44—Subcommittee on State and Local Health Administration, American Public Health Association 1790 B'way, New York, N. Y.

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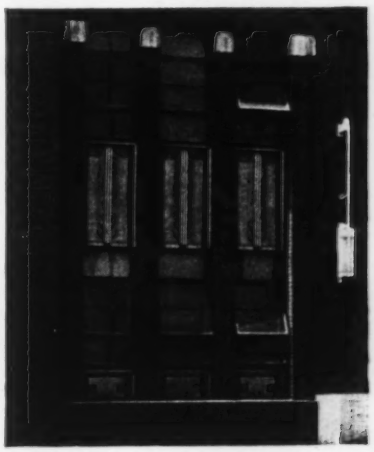

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CODE OF MINIMUM REQUIREMENTS FOR INSTRUCTION OF WELDING OPERATORS. Part A, Arc Welding of Steel $\frac{1}{16}$ to $\frac{1}{4}$ in. thick.—American Welding Society, New York 13, N. Y. 83 pp. 50c.

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PROGRESS REPORT ON THE EFFECT OF THE RATION OF WHEEL DIAMETER TO WHEEL LOAD ON EXTENT OF RAIL DAMAGE—Engineering Experiment Station Reprint Series No. 33. Published by the University of Illinois. 15c.

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BASIC DATA ON INCOME AND EXPENDITURES FOR PUBLIC WORKS IMPROVEMENTS 1920 to 1945—Department of City Planning, Pittsburgh, Pa.

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ENGINEERING COLLEGE RESEARCH ASSOCIATION—Directory of Member Institutions and Their Principal Fields of Research. 89 pp. Engineering College Research Association, Austin, 12, Texas.

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Reports and Pamphlets

ENGINEERS IN WORLD WAR II, A TRIBUTE—By Lt. Gen. Eugene Reybold, Chief of Engineers, U. S. Army, Corps of Engineers, Washington, D. C.

AHEAD WITH HIGHWAY TRANSPORTATION—National Highway Users Conference, National Press Bldg., Washington 4, D. C.

HIGHWAY TRAFFIC—Conference Proceedings, Eno Foundation for Highway Traffic Control, Saugatuck, Conn.

A TAX PROGRAM FOR A SOLVENT AMERICA—By The Committee on Postwar Tax Policy, The Maurice and Laura Falk Foundation, Farmers Bank Bldg., Pittsburgh, Pa.

APPROVED STATE AND MUNICIPAL PROJECTS (Oct. 1, 1945)—New York State Postwar Public Works Planning Commission, Albany, N. Y.

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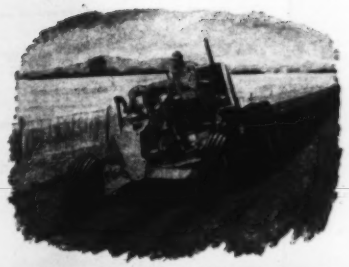

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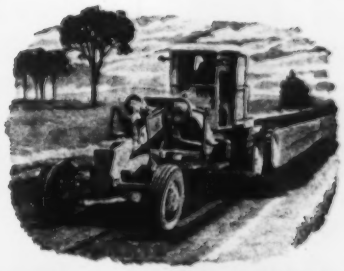

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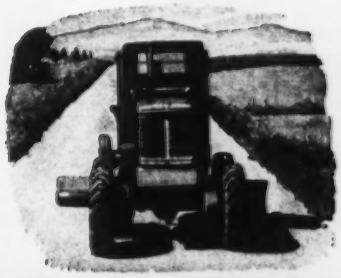

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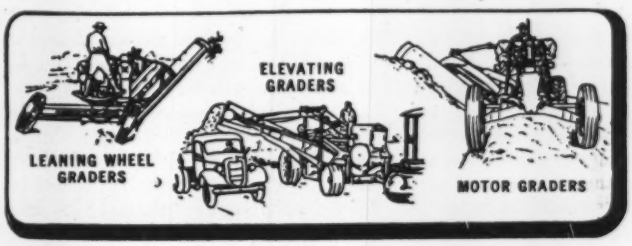

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Tampa, Epperson & Company
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Ida., Boise, Olson Manufacturing Company
Ill., Chicago, Chicago Construction Equipment Co.
Maine, Portland, Maine Truck-Tractor Company
Mich., Muskegon, Lakeshore Machy. & Supply Co.
Minn., Minneapolis, Phillippi-Murphy Equip. Co.
Mo., Clayton, The Howard Corporation
Montana, Billings, Interstate Truck & Equip. Co.
Helena, Caird Eng. Works
N. Y., Albany, Milton-Hale Machinery Company
New York, Hodge & Hammond, Inc.
New York, Railroad Materials Corporation
N. D., Fargo, Smith Commercial Body Works, Inc.
Okla., Oklahoma City, Townsco Equip. Company
S. C., Columbia, Smith Equipment Company
Tenn., Knoxville, Dempster Bros., Inc.
Vt., Barre, A. M. Flanders, Inc.
Va., Richmond, Highway Machinery & Supply Co.
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Pa., Philadelphia, Giles & Ransome
Wilkinsburg, Arrow Supply Company
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Houston, McCall Tractor & Equip. Company
San Antonio, San Antonio Mach. & Supply Co.
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San Antonio, Patten Machinery Company
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Holyoke, Massachusetts

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Rubber-Asphalt Compound

Rubber, asphalt and other ingredients are combined in Careylastic, a new hot-poured compound for sealing joints in concrete paving and construction. It is said to obtain a perfect bond throughout the entire range of annual temperatures, and to remain resilient and cohesive while permitting normal compression and recovery of the non-extruding fiber joint filler.

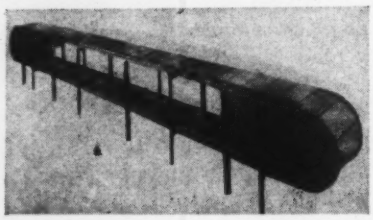
As this waterproof substance does not require yearly cutting out, cleaning and repouring of the joint seal, it eliminates expensive maintenance.—*The Philip Carey Mfg. Co., Lockland, Cincinnati 15, Ohio.*

• • •

All-Steel Conveyor Belt

Made up of a series of steel plates linked together at the ends, a new all-steel conveyor belt, "Steelok," is driven by a simple drive sprocket that meshes with the belt hinges. As there is no sag along the belt length, and no open spaces between links, a flat working surface is presented at every point. "Steelok" is said to be virtually noiseless in operation.

This conveyor handles both light and heavy materials efficiently, the manufacturer asserts, and it is engineered to individual specifications. The drive



sprocket and motor are enclosed, and the edges of the belt are provided with a guard rail.—*Steel Parts Mfg. Corp., division of the Blackstone Mfg. Co., Morgan & Quincy Sts., Chicago, Ill.*

• • •

Two-Color Spray Gun

Two-coat spatter finishes and simulated hammer finishes giving the effect of iridescent metal are now possible with Dimenso, a gun which sprays two colors simultaneously through one nozzle. This device provides a one-operation finish for light-gage steel faster and cheaper than by other hammer and spatter methods; the smooth finish has no dust-collecting cracks, wrinkles or fissures. The gun has normal spray fan control and fluid control valves, trigger

assembly, head, fluid tip and needle; an additional fluid inlet near the head accommodates the second color paint.—*The Sherwin-Williams Co., Cleveland, Ohio.*

• • •

Deep-Throated Clamp

A new line of C-type clamps have extra deep throats and are said to hold work with a firm tension grip on any surface. The clamp may be positioned instantly by pushing down on the ratchet screw and tightening with a turn of the loose-proof handle. The trigger release pawl has hardened teeth which hold a meshed grip under spring tension on the ratchet screw.

This speed clamp, in three sizes, has copper-plated working parts and a rustproof baked enamel finish.—*Grand Specialties Co., Grand Ave., at Troy, Chicago 22, Ill.*

• • •

Portable Cement Batcher

Featuring unusual portability, a new twin-silo cement batching plant has been developed in storage capacities of 761, 1,044, 1,327 and 1,600 barrels. Constructed of all-welded units, this plant can be set up quickly, without a crane if desired. It may be charged from box or hopper cars, or from trucks.

The leg section on the overhead silo is so designed that it can pivot on a base plate mounted in the concrete footing. The pivot can then be utilized to tip the entire leg and silo assembly into place by means of a gin pole and a

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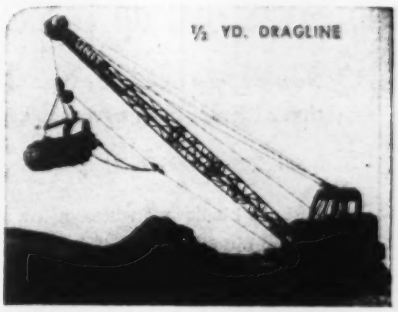

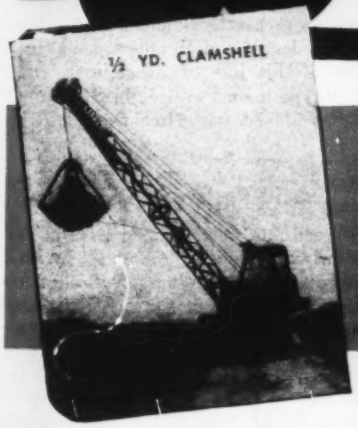

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INDUSTRIAL PEERLESS PHOTO PRODUCTS

tractor winch. The Johnson Bin-Gage indicates the level of the cement in the silo.—*The C. S. Johnson Co., Champaign, Ill.*

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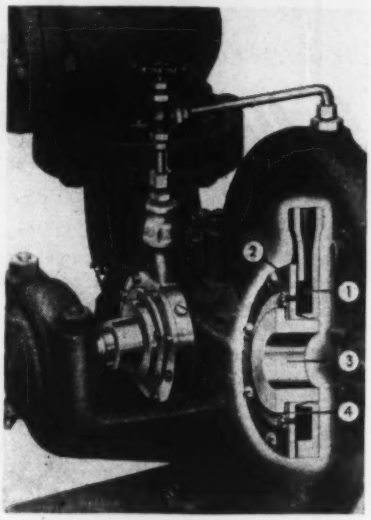
Jet Shaft Seal

A large saving in pump maintenance costs is effected by a new jet shaft seal, it is claimed. In principle, the seal draws pressure from the high point, directing it back into the low pressure area of the pump with sufficient force



to seal off internal pressures. Since the shaft sleeve turns with the shaft, but is not in contact with the orifice plate, there is no point of wear. The diaphragm is said to provide a leak-proof seal when the pump is not operating.

The seal, in bronze or stainless steel, is made for pumps with 1 in. shafts or over.—*Jet Shaft Seals, Inc., 1452 South San Pedro St., Los Angeles 15, Calif.*

• • •

Hot Water Meter

Now available for metering hot water up to 250 deg. F., the Builders Propeloflo meter employs a special high-temperature grease for efficient lubrication. Venturi design and all other special features of this line of streamlined, propeller-type meters are retained.—*Builders-Providence, Inc., Providence 1, R. I.*

• • •

Acid-Resistant Wood

Forced into wood under pressure, the recently developed "Asidbar" bituminous plastic renders lumber resistant to chemicals, acids, moisture, decay and wear. This coal-tar plastic increases the weight and hardness of the wood, giving a black surface which need not be painted.

Treated wood can be installed with or-

dinary wood tools, and will withstand severe service conditions at temperatures to 180 deg. F.—*Koppers Co., Inc., Wood Preserving Technical Department, Orrville, Ohio.*

• • • •

Small Engine

Principles new in small engine design are embodied in a new 5 hp. all-purpose, air-cooled engine, called the "Busy Bee". This 4-cycle, L-head engine, rated 5 hp. at 2,600 rpm., develops 6 hp. at 3,250 rpm. The single cylinder is horizontal and detachable. This AB-3 unit, requiring only 2.4 cu. ft. of space, makes use of aluminum alloy in crankcase, piston, head, and crankcase and rear cover.—*Kinner Motors, Inc., Glendale, Calif.*

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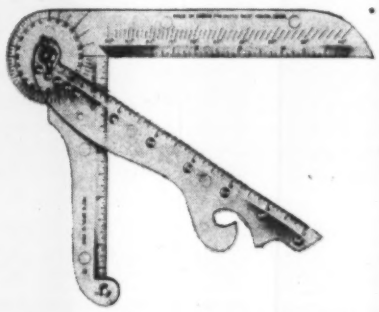
Drawing and Measuring Device

Virtually eight instruments in one, Parva-graph, a new drawing and measuring device, serves as a square, divider, protractor, triangle, ruler, compass,



french curve and mitre. It consists of two parts: a combination square and a removable mitre arm to be mounted on the square through either of two mounting holes. The mitre arm, locked at any desired position by a wing nut, can form angles of any degree; if the arm is removed and used as a radius, ½ to 14 in. dia. circles can be scribed.

This device of tough, transparent plastic is boxed, with complete instructions for use.—*Para Products Co., West Haven, Conn.*

• • •

Light Electrode Holder

One-third lighter than a corresponding size clamp-type holder, a new screw-type electrode holder decreases fatigue. Exposed metal surfaces are of spatter-resistant Mallory metal and simplified design facilitates easy replacement of parts. Available in light and heavy duty sizes to accommodate electrodes up to ⅜ in. diameter, the holder has heavy insulation and adequate handle ventilation.—*Allis-Chalmers Mfg. Co., Milwaukee, Wis.*

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CLAY PIPE

ESPECIALLY designed to meet modern construction needs and practices, Extra-Strength Clay Pipe is enabling engineers and builders to take full advantage of labor-saving, economical mechanical equipment. For example, Extra-Strength Clay Pipe stands up under the heavier backfill load of wider trenches dug by draglines . . . withstands the extra strain imposed by trench bottoms which often do not provide strongest support for the pipe.

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MEN AND JOBS

Expansion of the New York offices of The H. K. Ferguson Co. industrial plant designers, engineers and builders, has been announced by **A. Kingsley Ferguson,** president of the company.

The 27-year-old concern has occupied offices for sales at 25 West 43rd St., and for engineering and construction at 420 Lexington Ave. Now the two offices are consolidated in greatly increased additional space at 119 West 57th Street.

G. E. MacMillin

T. K. Rothermund

C. A. Driver

G. E. MacMillin, contract manager for the eastern division, will direct sales and preliminary engineering. **T. K. Rothermund,** chief district engineer, will head the newly expanded engineering department. **C. A. Driver** will supervise all construction along the eastern seaboard and in New England.

W. L. Harwell, city engineer of Tampa, Fla., has resigned to enter private business. Assistant City Engineer Fagan is serving temporarily as head of the engineering department.

Frank A. Busse, consulting engineer, has re-opened his office in Memphis, Tenn., after almost five year's absence working on the construction of military establishments, including the U. S. Naval airbase at Bermuda, and structural work at Oak Ridge, Tenn.

The Chicago, Milwaukee, St. Paul and Pacific Railroad has announced the retirement, at his own request, of **W. H. Penfield,** chief engineer, with headquarters in Chicago. He has been succeeded by **R. J. Middletown,** assistant chief engineer since 1933.

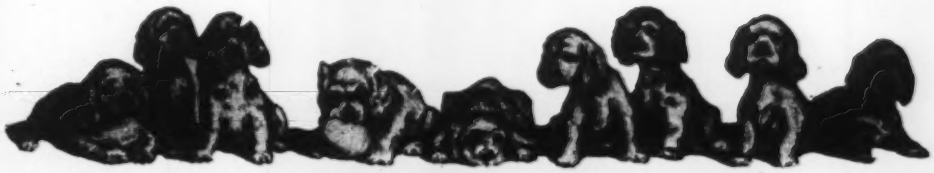
Albert Bauer has been appointed assistant general manager of the Swan Island Shipyard at Portland, Ore. He was an engineering graduate of Oregon State College in 1922. After working for the Portland water bureau on Bull Run Dam and the Electric Bond & Share Co. on a hydroelectric investigation in Mexico, he joined the U. S. Engineers at Bonneville Dam in 1933, becoming head of the operations department in charge of construction and maintenance in the Bonneville engineer district.

S. T. Larsen is now serving as superintendent of the Bureau of Reclamation's Belle Fourche project in western South Dakota, succeeding **F. C. Youngblutt** who retired recently. Mr. Larsen was formerly in the branch of operations and maintenance at the regional office, Billings, Mont. Mr. Youngblutt had been employed by the bureau almost continuously for 39 years. He went to Belle Fourche in 1921 and in 1924 was appointed superintendent.

Maj. Ralph S. Howard, Jr., has been elected Dougherty County, Ga., public works superintendent to succeed the late John Lowe. He has been associate chief of the engineering division of the U. S. Public Health Service at Atlanta. Maj. Howard is a graduate of Clemson College and took post-graduate work in engineering at Harvard. At one time he was in charge of the Georgia State Health office in Macon. He spent two and one-half years with an American sanitary mission to Haiti, looking after the sanitation problem in connection with Army and Naval bases in the West Indies. He was promoted to district superintendent of Central and South America with headquarters in Washington.

J. R. Traphoner has been named division engineer for the North Florida division, Seaboard Railway, Jacksonville, succeeding **W. R. Cox,** transferred to Tampa as division engineer for the South Florida division; **J. F. Powell, Jr.,** is appointed assistant to the division engineer; **W. R. Cox,** is the new division engineer for the South Florida division; **J. H. Gill,** division engineer for the Alabama division at Savannah, was appointed assistant to the chief engineer succeeding J. R. Traphoner.

Jack Y. Long has announced the formation of the J. Y. Long Co., engineers, Oakland, Calif., to handle structural design, general civil engineering and land surveys. All partners have been associated with leading engineering organizations in



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24 Effluent Controllers, Filter Pipe Gallery.

Metropolitan Water District of Southern California

Photos courtesy Metropolitan Water District

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FINISHING TOOLS FOR CONCRETE ROADS

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California for a number of years.

Summer C. Willis has returned to the H. K. Ferguson Co., industrial engineers and builders of Cleveland, Ohio. On leaving Ferguson in 1943, he was employed as production manager for the National Co., radio engineers and manufacturers, Malden, Mass. Later he was senior project engineer for the General Cable Corp., at the Perth Amboy, N. J., plant.

Jacob Mark, consulting engineer, has moved his office from Brooklyn to Manhattan, New York City.

Echols Ball, assistant Duval County, Fla., engineer, has returned to his former position in Jacksonville.

Frank W. Herring, formerly executive director of the National Resources Planning Board, has been promoted to commander in the Navy Civil Engineer Corps reserve. Commander Herring as historical division head in the Bureau of Yards and Docks, Washington, D. C., is preparing the war history of the Bureau of Yards and Docks and the Civil Engineer Corps.

A new engineering firm has been organized in Lubbock, Tex., composed of **G. W. Parkhill, M. R. Smith, Jr.,** and **S. C. Cooper.** It is Parkhill, Smith & Cooper. Mr. Parkhill was formerly instructor at Texas Tech., Lubbock; Mr. Smith was city manager of Lubbock and Mr. Cooper was city engineer of Big Spring.

Arthur E. Morgan, Yellow Springs, Ohio, former chairman of the Tennessee Valley Authority, has been named chairman of the Conservation Committee of the Ohio Postwar Program Commission. He served as chief engineer of the Miami Conservancy District established after the 1913 flood in Dayton. He drafted drainage codes adopted by the legislatures of Minnesota, Mississippi, Colorado, New Mexico and Ohio.

O. A. Zimmerman is with the Maxon Construction Co., Dayton, Ohio, as construction engineer. He is a graduate civil engineer, University of Kansas and was formerly chief engineer and later vice-president of the Kansas City, Mo., Bridge Co.

The following officers of the United Engineers & Constructors, Inc., Philadelphia, Pa., have been elected:

Vice president and consulting engineer, **Charles W. E. Clarke,** who has specialized in the field of steam engineering for the last 35 years; vice-presidents and construction managers, **Stanley C. Cook,**

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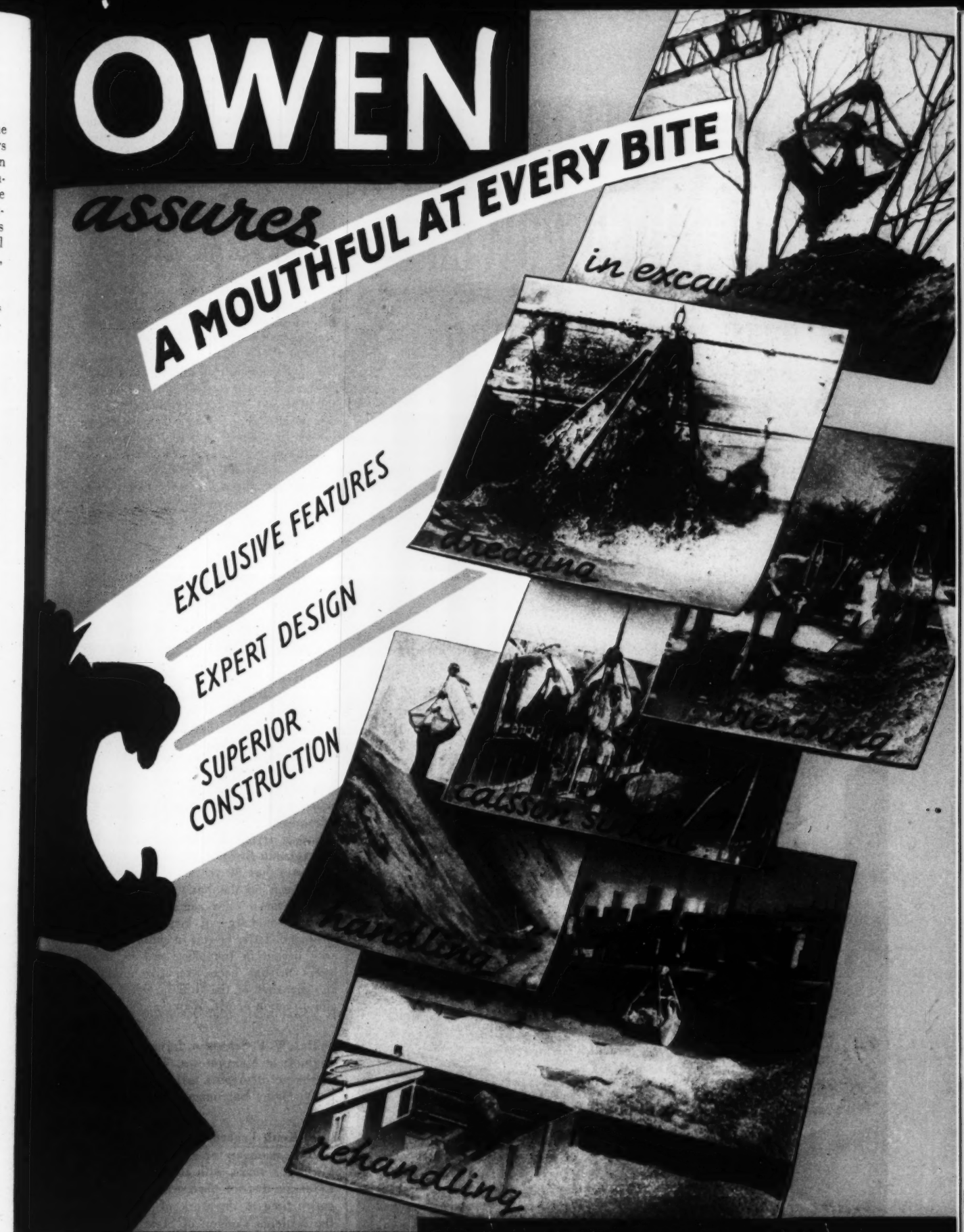

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who has been construction manager of many large industrial and institutional developments, and **Benjamin S. Thayer**, who has been in charge of much steam power plant and industrial work in this country, and also subways and other important work in Buenos Aires and elsewhere in South America.

Lt. Col. Norman J. Riebe, U.S. district engineer for the Buffalo, N. Y., area since January, 1944, is leaving to return to private construction. He will be replaced by **Col. Herbert J. Vogel,** who returned recently from the South Pacific. Colonel Riebe was chief of the Panama Division's engineering and contract work, hacking defense projects, air fields, cantonments and artillery positions from virgin jungles. Before that he was in charge of the Fort Knox construction program.

Military supply activities are now virtually completed in the Buffalo district, which had shipments worth more than $10,000,000 a month during the war. It was the second highest production district in the Corps of Engineers.

Col. Kenneth M. Moore, new Duluth, Minn., district engineer, has taken over the U.S. Army Engineers' office to assume his new duties. Colonel Moore served as an engineering captain in France and Germany in World War I. He succeeds former district engineer **Col. Schenk H. Griffin,** retired, who has made his home in Washington, D. C.

Charles R. Waters, district engineer, N. Y. State Department of Public Works, has announced that **Elmer G. H. Youngmann** has been appointed assistant district engineer in the Buffalo Office. He succeeds Irving T. Storm, retired. Mr. Youngmann has been in the department for more than 30 years. His promotions have been on the basis of civil service examinations. For some years he was engineer-in-charge of large construction projects. Later he was in charge of highway design in the office and in recent years he has been executive engineering manager of the Buffalo Office under the direction of Mr. Waters.

Maj. W. F. Schwerin, formerly resident engineer at Morgantown, W. Va., will be in charge of surplus material at Albany, N. Y., Army Engineers depot.

T. Keith Legaré, who has been WPB district manager for South Carolina for the last 3 years, with the closing of the Columbia district office, will now give his entire time to the work of secretary of the National Council of State Boards of Engineering Examiners and of the South Carolina state board of engineering examiners.

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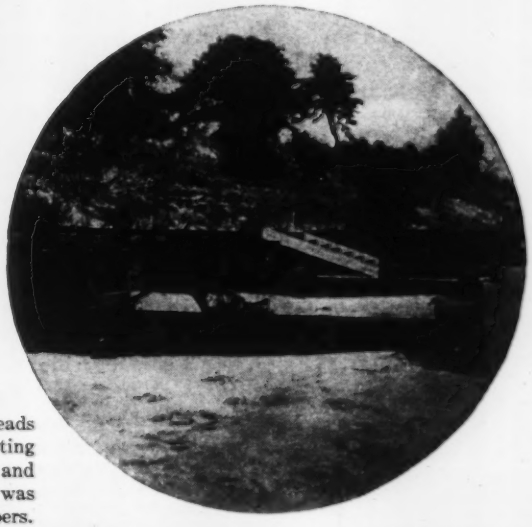
Construction

TARMAC IS THE IDEAL PRIME COAT

Tarmac penetrates quickly and deeply and binds when it has penetrated. By binding together the penetrated aggregate, it increases the stability of the surface and helps form a more perfect bond between the surface course and the base course. Tarmac prime coats set up while penetrating the surface.

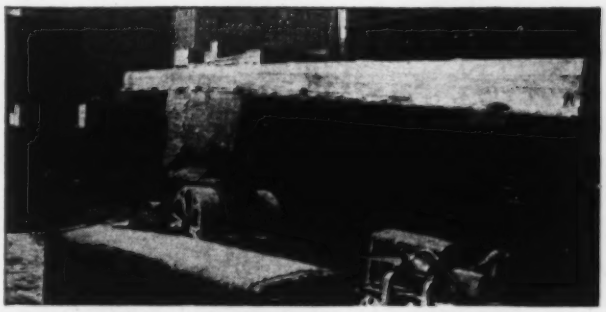


PRESSURE-TREATED WOOD BULKHEADS SAVE SHORELINE

There are ten miles of these pressure-treated wood bulkheads and groins in this Maryland installation. Pressure-creosoting gives long-lasting dependable protection against decay and (in salt water) against marine borers. This timber was pressure treated by the Wood Preserving Division of Koppers.

COAL TAR PITCH PROTECTS CLOVERLEAF RETAINING WALL

Coal tar pitch is widely used to protect concrete and masonry structures because it possesses the ability to resist the deteriorating effects of prolonged continuous or intermittent contact with water. In this picture it is being applied to a wall of a cloverleaf on a major traffic artery in Pittsburgh.



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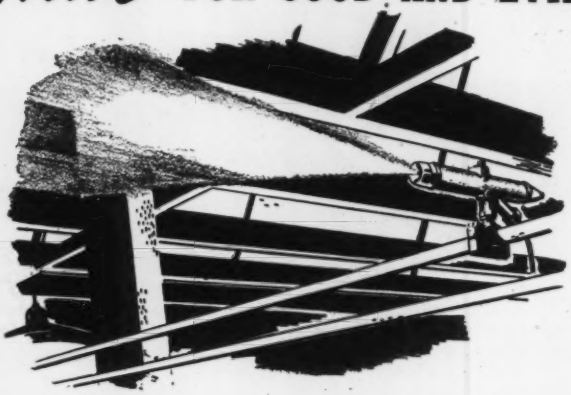
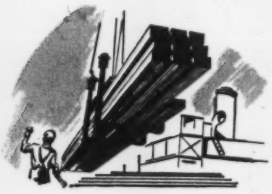


Mist, sprayed in process plants requiring high humidity, is vital to the quality of many products. But, it raises havoc with the wood structures. And steam and chemical-laden vapors in wet process plants cause ordinary lumber to go to pieces in a hurry.

Wolmanized Lumber*, wood that's impregnated with Wolman Salts* preservative, is highly resistant to the decay that inevitably develops in these humid atmospheres. Fibre-fixation prevents its washing out or leaching, assures added years of service life.

The Advantages of Building with Wood



Building with wood means ease and speed of erection, light weight, resilience, high insulating value, paintability, low first cost and . . . when Wolmanized . . . long life.

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Elections and Activities

The Bradley Engineering Society has been formed at Bradley College, Peoria, Ill. Elected president was Robert Steimel, Peoria; vice president, Morris Philpott, Ottawa; treasurer, J. Gray, New Philadelphia; secretary, Marvin Bonnett, Stockton. Faculty honorary members are: Prof. C. M. Hewitt, F. E. Dace, R. F. Stainton. Faculty advisor of the society is George F. Branigan, dean of engineering.

The New York Metropolitan Chapter of the American Association of Engineers has elected the following officers: President, George Williams; first vice-president, Charles J. Moody; second vice president, Arthur Richards; treasurer, Robert H. Place; Secretary, Eugene T. Lake; directors, James P. Welsh, Edward W. Kozlowski and Y. Mombelly.

Arizona Section, A.S.C.E., has elected officers as follows: President, George T. Grove, Pima County engineer, Tucson; first vice president, Lawrence R. Dail, contractor, Phoenix; second vice president, Walter Johannessen, of Johannessen & Girand, consulting engineers, Phoenix; and re-elected John A. Baumgartner, Water Resources Branch, U. S. Geological Survey, Tucson, secretary-treasurer. These officers, with retiring president Wayne G. O'Harra, of Arizona Highway Dept., Phoenix, are the board of directors.

Frank L. Weaver, chief of the river basin division of the Federal Power Commission, was elected president of the District of Columbia Section, American Society of Civil Engineers at a recent meeting. Mr. Weaver succeeds Benjamin E. Jones, power hydraulic engineer with the U. S. Geological Survey. Other new officers are: Vice-president, W. G. Hoyt, executive secretary of the water resources committee of the Department of the Interior; secretary, C. J. Stevens, senior engineer with the Bureau of Yards and Docks, U. S. Navy; and treasurer, A. L. Cochran, of the U. S. Army Engineers.

At the meeting certificates of life membership were presented to eight members. These were: William L. Fulton, Interstate Commerce Commission; James N. Gladding, formerly with the War Production Board and now the Civilian Production Administration; Clarence S. Jarvis, Office of the Chief of

DAY OR NIGHT

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Specify Hewitt for quality industrial rubber products. Phone the Hewitt distributor listed in the Classified Section of your telephone directory . . . or write to the Hewitt Rubber Corporation, 240 Kensington Avenue, Buffalo 5, N. Y.

Quality Rubber Products for Industry for 86 Years

HEWITT RUBBER

of Buffalo

Job-Engineered Industrial Hose • Belts • Molded Goods

Helical gears used in Fuller two-speed and three-speed transmissions not only assure smooth, quiet operation, but also guard against clashing or raking during the shift . . . protect the *working teeth* by the use of jaw clutches to engage the different ratios. Here's another reason why Fuller Auxiliaries have an *insured* long wear-life . . . an average of 200,000 miles of uninterrupted service!

FULLER MANUFACTURING COMPANY, TRANSMISSION DIVISION
KALAMAZOO 13F, MICHIGAN
Unit Drop Forge Division, Milwaukee 1, Wisconsin

Fuller TRANSMISSIONS

"GUNITE" CONCRETE

For ● Steel Plate Lining ● Steel Encasement ● Building Walls, Roofs, Facings ● Tunnel Lining ● Water Reservoir Lining ● Power Plants — Bunker Lining ● Sewer Repairs ● Tank Lining ● Canal and Ditch Lining ● Repairs of Disintegrated Concrete, Brick, Tile, Masonry

• • WRITE • • • PHONE • • • WIRE • •

GUNITE CONCRETE AND CONSTRUCTION CO.

1301 WOODSWETHER ROAD ● KANSAS CITY, 6, MISSOURI
DISTRICT BRANCH OFFICE: 228 N. LaSalle Street, CHICAGO 1, ILL.
BRANCH OFFICES: ST. LOUIS • DENVER • DALLAS • HOUSTON • NEW ORLEANS

Engineers; Rear Admiral Charles A. Park, U. S. Coast Guard; Glenn L. Parker, U. S. Geological Survey; Frank C. Starr, consulting engineer; William A. Van Duzer, director of vehicles and traffic, District of Columbia; and Albert H. Worley, Public Roads Administration.

Herbert J. Dunsmore, sanitary engineer of the Calhoun County, Mich., health department, has been elected vice president of the Michigan Association of Sanitarians. Henry Kowalk, Flint, was elected president. Other new officers are: LaRue L. Miller, of the state health department's board of engineering, secretary-treasurer; and Philip Shirley, Ingham County health department, assistant secretary-treasurer. Percy Phelps, Grand Rapids, was named the association's representative to the Michigan Public Health association.

The Oregon Association of County Engineers has re-elected S. B. Morgan, of La Grande, president, with P. M. Morse of Eugene vice-president and Paul M. Rynning of Medford secretary-treasurer.

New officers of the Carolinas' Branch of the Associated General Contractors of America are: Edwin L. Jones, Charlotte, N. C. president; and C. Y. Thomason, Greenwood, S. C., vice-president.

Wisconsin section of the American Water Works Association has elected Joseph P. Schwada, Milwaukee city engineer, a director on the national board of the American Water Works Association. Officers elected are: Harold Londo, superintendent of the Green Bay Water Department, chairman; John J. McCarthy, Racine Water Department chemist, vice chairman, and Verne Somers, superintendent of the Stevens Point Water Department, director.

Harold J. Dillehay, of Charlotte, has been elected president of the North Carolina Council of Housing Agencies. Dillehay, who has been vice-president, succeeds H. R. Emory of Wilmington. Other officers elected are: H. Emmett Powell of Clinton, vice president; and Mrs. Inez B. Jones of Raleigh, re-elected secretary-treasurer.

Walter J. Shapter, Jr., has been re-elected president of the Columbus, Ohio, Home Builders Association. Clyde R. Montgomery was elected vice-president, and Earl S. Washburn, secretary-treasurer and a member of the board of directors of the association. Others named to the board were Carl J. Wright, and K. D. Shaw.

America's most complete line of material handling buckets.

WE BUILD ALL 4 MATERIAL HANDLING BUCKETS

PMCO ALL PURPOSE

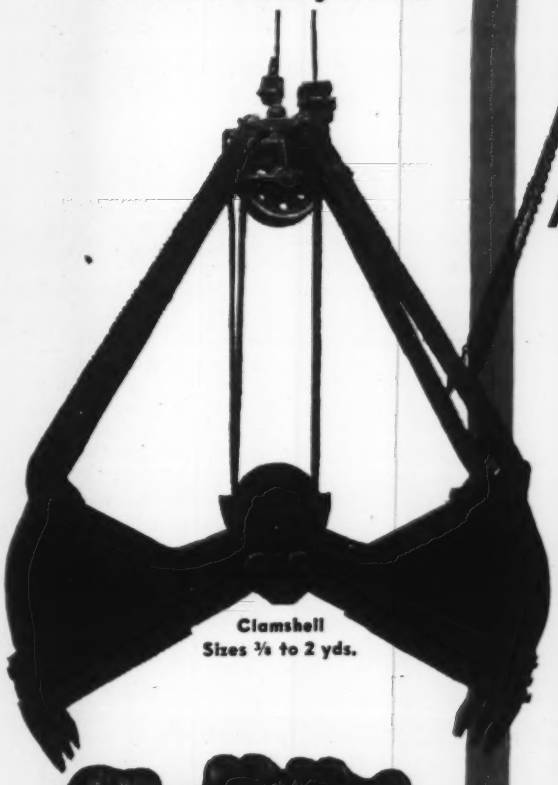
- SHOVEL
- PULLSHOVEL
- DRAGLINE
- CLAMSHELL

We build a wider and more complete line of material handling buckets than any other manufacturer. Volume production methods enable us to build a better bucket with amazing economies in manufacturing.

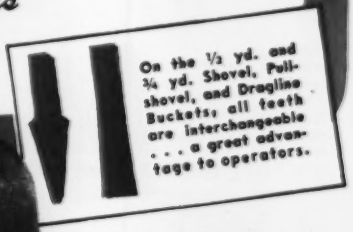
FRONTS, BOTTOMS, SCOOPS, and TEETH, shown in red on buckets, are 14% manganese steel developing up to 120,000 tensile p.s.i. for long service life and hard abuse.

Experience Counts

See your shovel engineer or equipment dealer about PMCO Dippers and Buckets.



Clamshell
Sizes ⅜ to 2 yds.



On the ½ yd. and ¾ yd. Shovel, Pullshovel, and Dragline Buckets, all teeth are interchangeable . . . a great advantage to operators.

Shovel
Sizes ⅜ to 18 yds.

Dragline
Sizes ⅜, ½, ¾, 1, 1½, 2, 2½ yds.

Pullshovel
Sizes ⅜, ½ and ¾ yd.

Quality Since 1880

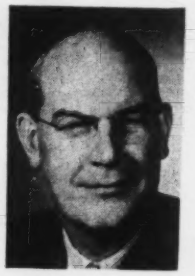
PETTIBONE MULLIKEN CORP.

CHICAGO 51, U. S. A.

WE OPERATE THE LARGEST AND MOST COMPLETE MANGANESE STEEL FOUNDRY IN THE UNITED STATES.

Manufacturers' Activities

J. L. SINGLETON has been appointed manager for the 60 district offices of the Allis-Chalmers general machinery division's sales department at Milwaukee, Wis., according to William C. Johnson, vice president.



Mr. Singleton joined Allis-Chalmers in 1926 after receiving a B.S. degree in mechanical engineering from Alabama Polytechnic Institute. He was granted a leave of absence to work as a power plant engineer for a large Chicago firm in 1928, returning in 1938 as office manager of the company's district office at Denver, Colo. In 1942 he was transferred to the West Allis works as assistant to the manager of the steam turbine department and became assistant manager seven months later, which position he held until his recent promotion.

W. H. HAMMOND has been promoted to the newly created post of vice-president in charge of sales of Gar Wood Industries, Inc., Detroit, Mich. Mr. Hammond was formerly sales manager of the hoist and body and tank divisions only and director of branches with the title of vice-president. In his new position he will supervise the sales activities of the winch and crane, road machinery, heating and boat divisions in addition to those formerly under him. He will continue as director of branches.

Mr. Hammond joined Gar Wood as a bookkeeper in its Philadelphia branch in 1921, shortly after his discharge from the Army. He was named manager of the Baltimore branch in 1925 and of the Boston branch in 1929. He went to New York in 1933 to head Gar Wood's activities there and in January, 1934 assumed the position he has just vacated.

RUDOLPH R. ROTHENBERG has been appointed manager of the New York office of American 3-Way-Luxfer Prism Co., Inc., Chicago daylight engineering concern. Mr. Rothenberg has just completed a 4-year assignment with the War Department as Air Technical Service Command representative, having been recently stationed at Republic Aviation Corp. Prior to that Mr. Rothenberg was associated with Ira Haupt & Co. for nine years.

JOSEPH C. NORTON, 81, one of the founders of the 57-year-old Norton Bros. Co., Cleveland roofing contractors, died recently. He was a charter member of the Cleveland Builders' Exchange and a past president of the United Roofing Contractor's Association.

H. H. MUNSON, Chicago, has been appointed manager of the newly organized industrial instruments division of the Claud S. Gordon Co. Munson formerly was with Manning, Maxwell & Moore, specializing in engineering and selling. In his new position he will be in charge of applications and sales of such industrial instruments as indicating and recording thermometers and gauges, regulators and all types of process control instruments.

JOHN A. MORAN, former Ohio District Engineer, Clay Sewer Pipe Association, Columbus, Ohio, on leave-of-absence for the last year and a half as chief of the Clay Products Unit, Building Materials Branch of OPA, Washington, D. C., resigned recently and has returned to the general office staff of the association.

R. L. ROBINSON has been named sales manager of the aggregates division of Pacific Coast Aggregates, Inc. His headquarters will be in San Francisco. J. J. Penrose will head the company's sales force at Sacramento.

RETIREMENT of Charles Scheneck, engineer of development, Bethlehem Steel Co., has been announced. He had been with Bethlehem since 1918 and was one of the pioneers in the art of electric welding of steel.

EDWIN A. WERT has been appointed general manager of the southwest region—Arizona, California, Colorado, Utah, and New Mexico—for the Kennedy-Van Saun Manufacturing and Engineering Corp., New York, manufacturers of crushing, mining and cement machinery, pneumatic transport systems and screening, elevating, conveying and transmission machinery. Mr. Wert, formerly vice-president of the Blaw-Knox Co., Pittsburgh, will have headquarters in the Los Angeles, Calif., office.

ECONOMY PUMPS, INC., Hamilton, Ohio, has announced the appointment of E. E. Baker as manager of the distributor sales division. Mr. Baker will make his headquarters at Hamilton. He has already appointed the Aetna Engineering Co. with offices in Ashaway, R. I., Hanover and Boston, Mass., as distributors for Economy pumps throughout New England.

Mr. Baker is an engineering graduate from the University of Southern California. He was six years with Byron-Jackson Pump Co. and eleven years with Pomona and Fairbanks-Morse Co.

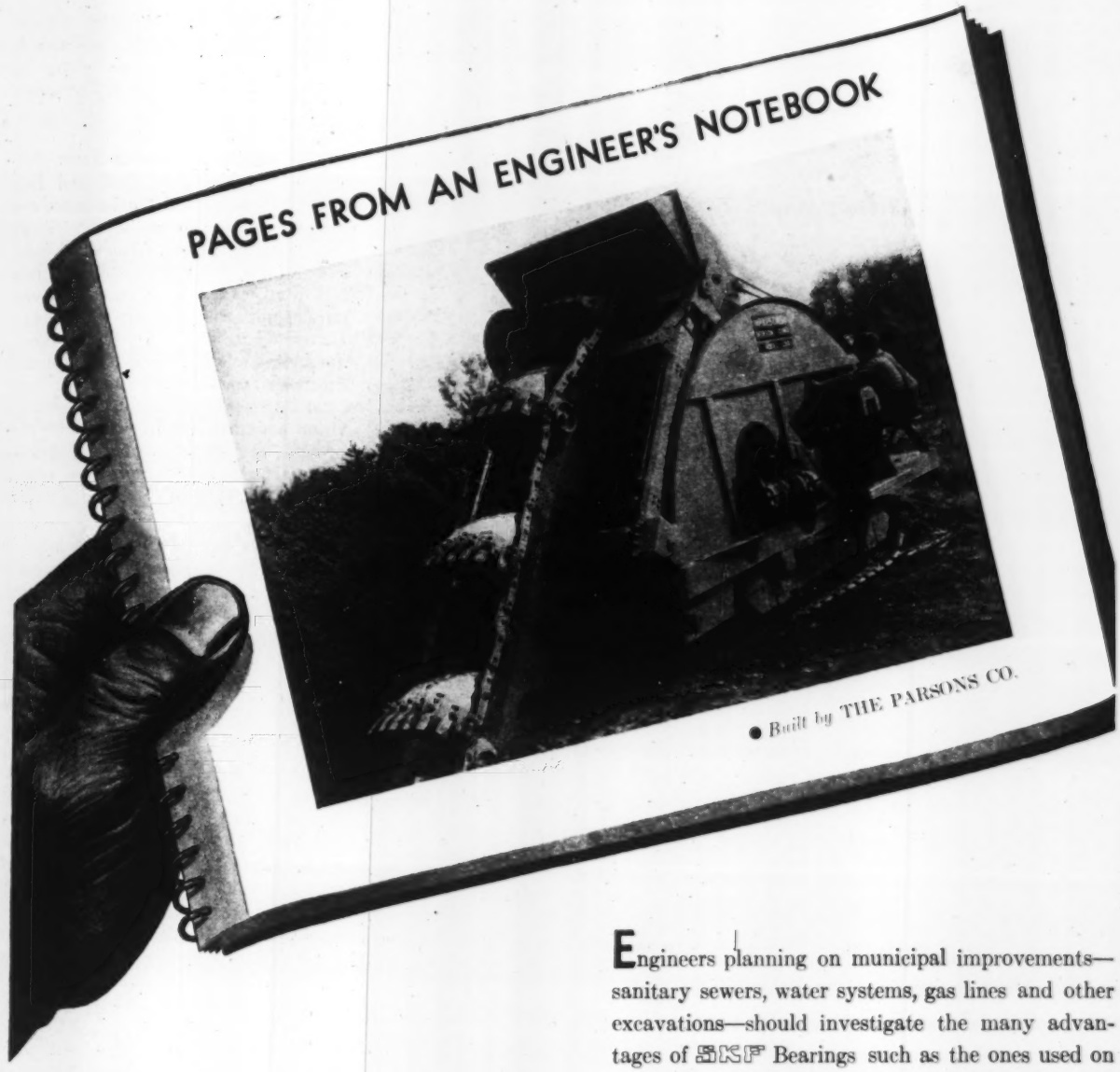
BACK into "civies" after two years as a captain in Army Ordnance, Jack Davies has been appointed district manager for sales of all Heil products in Tennessee, Alabama, Georgia, the Carolinas, and Florida. Headquarters for this district are in the Commercial Bank Building, Raleigh, N. C. Ray Long, who has been representing the company in this territory, will continue to work out of the Raleigh office but will concentrate on road machinery sales.

Davies started in the service department of The Heil Co. over 20 years ago, later served as sales representative successively in Wisconsin, Buffalo, Washington, D. C., and Atlanta.

THE GREGG CO. of Philadelphia, Pa., has announced that the Nicholson Engineering Co. of Camden, N. J., has been appointed as representative for the sale of Rusta Restor cathodic tank protection equipment and Nu-Type technical coatings in the southern part of New Jersey. A. C. Nicholson, who operates this concern has long been active in the marine field and also in connection with protective anti-corrosion coatings. He was formerly chief of W. A. Briggs Bitumen Co.

It is also announced that Burton Richards who was formerly with The Gregg Co. has returned after four and one-half years in the Army and is now manager of the Rusta Restor division with headquarters in the Philadelphia office.

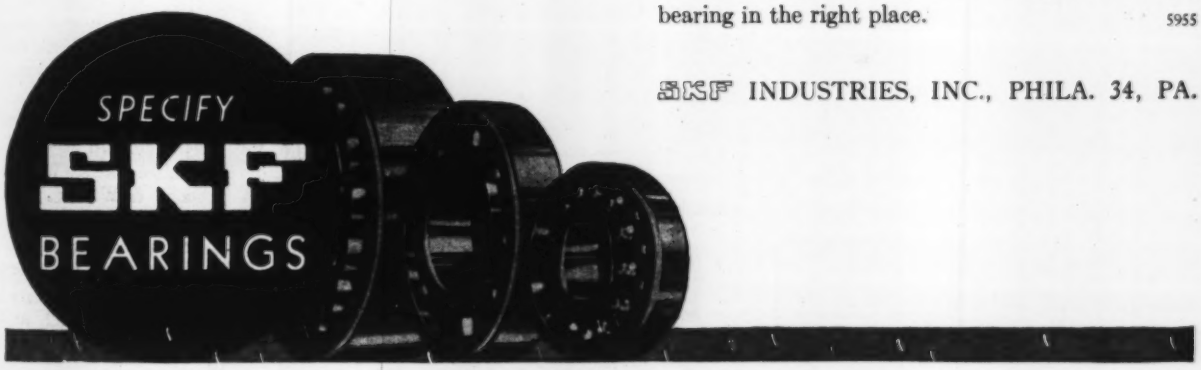
The Gregg Co. is the sales representative in eastern territory of The Johnston & Jennings Co. of Cleveland, Ohio,

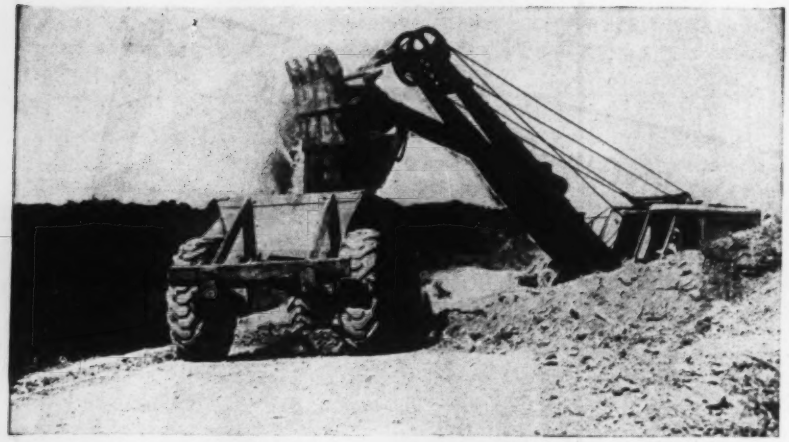


HELPING - - TRENCHLINERS DIG DOWN 12½'

Engineers planning on municipal improvements—sanitary sewers, water systems, gas lines and other excavations—should investigate the many advantages of SKF Bearings such as the ones used on this Parsons Model 250 Trenchliner, which digs trench from 16 to 42 inches wide and down to 12½ feet deep at digging speeds from 2½ to 136 inches per minute. They keep vital rotating parts in correct alignment, assure ease of operation, show practically no wear after years of service. The term "SKF-equipped" is your warranty of the right bearing in the right place. 5955

SKF INDUSTRIES, INC., PHILA. 34, PA.





Manganese Steel Found a Part in the Timely Production of the Atomic Bomb

Timeliness will always loom prominently in the history of the atomic bomb. Had this war-terminating weapon been available a year sooner, our casualties in the European theatre would have been much less. As it was, our losses in the Pacific were greatly reduced by its opportune advent. It is almost needless to state that American science and industry made every effort to have the atomic bomb ready for use at the very earliest date possible.

The rapid preparation of plant sites and the construction of access highways by the most advanced equipment, helped to speed the production of the atomic bomb.

Pictured above is a moment in the construction of a 23-mile stretch of access highway between Knoxville and the atomic bomb plant at Oak Ridge, Tennessee. A Link-Belt Speeder Series 300 shovel is loading a bottom dump Euclid. A 2 yd. Amsco Manganese Steel Renewable Lip Dipper is discharging its load.

Continuous operation was highly important on every phase of this project. Dippers that required time out for repairs could have seriously delayed what was then a vital link in the war effort.

Amsco dippers insure the greatest obtainable freedom from operating delays, as well as the longest wearing life, by the use of tough, work-hardening manganese steel throughout. Repeated impacts that would cause ordinary steel to fail serve only to surface-harden austenitic manganese steel, giving it incomparable resistance to abrasive wear. Amsco design contributes fast, full loading and clean dumping. With Amsco Renewable Lip Dippers, it is not necessary to scrap the entire front when the lip has become worn. Lips are quickly changed.

Send for Bulletin 641-D on Amsco Dippers.

How Amsco Conservation Welding Products Keep Construction Equipment on the Go is told in Bulletin 941-W.

AMSCO

Foundries at
Chicago Heights, Ill.; New Castle, Del.;
Denver, Colo.; Oakland, Calif.;
Los Angeles, Calif.; St. Louis, Mo.
Offices in Principal Cities

AMERICAN MANGANESE STEEL DIVISION
CHICAGO HEIGHTS • ILLINOIS

AMERICAN Brake Shoe COMPANY

manufacturers of Rusta Restor cathodic protection equipment. P. S. Wilson is vice-president in managerial charge of the Rusta Restor division of The Gregg Company.

THE WICKWIRE SPENCER STEEL division of the Colorado Fuel and Iron Corp. has purchased the business and assets of the Coburn Trolley Track Co., Holyoke, Mass. The steel company will immediately assume full control of all management, production and sales operations of Coburn, which manufactures hardware for sliding doors, garage, warehouse, automatic fire and overhead doors and hardware for overhead conveying equipment. Coburn division operations will continue for the present at Holyoke, where Coburn's manufacturing plant and sales offices are located.

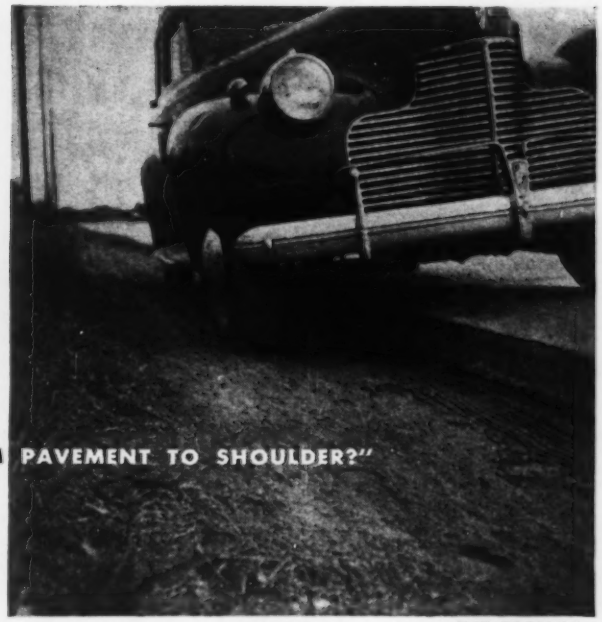
BAILEY VIBRATOR CO., Philadelphia, Pa., recently has been combined with Stow Manufacturing Co., Binghamton, N. Y. Nelson Stow made the first flexible shaft in 1875; and ever since Bailey originated the flexible shaft type concrete vibrator, Stow products have been a part of that equipment. With the cooperation of R. G. Gage, formerly in charge of engineering of the New Jersey State Highway Department, Bailey is said to have the first full-width vibrating screed in the United States for concrete roadway construction and marketed the first pneumatically powered internal type concrete vibrator. As consulting engineer for Stow, Mr. Bailey is in charge of the new development work and streamlining on vibrators. In addition, he is in charge of the Philadelphia office where Stow's export activities are conducted. P. C. Jolly, who was for many years associated with Bailey Vibrator Co., is now with Stow at Binghamton.

NORTH A. WRIGHT has been named public relations director of Libbey-Owens-Ford Glass Co., Toledo, Ohio, which he joined in November, 1933. He was the company's Washington representative during the war years.

THE RETIREMENT of William Sheldrick, who has been an official of the Babcock & Wilcox Co., for 46 years, and the appointment of W. G. Dryden as his successor has been announced. Mr. Sheldrick was treasurer and assistant secretary of The Babcock & Wilcox Co. and The Babcock & Wilcox Tube Co. Mr. Dryden succeeds to those positions. Mr. Sheldrick first served as secretary to W. D. Hoxie, vice president and later president. He was elected treasurer of the company in 1932, and of the Tube Company three years later.

"Are any of your roads too narrow?

. . . OR HAVE THEY DANGEROUS DROPS FROM PAVEMENT TO SHOULDER?"



THE PROBLEM

Roads too narrow to carry today's fast-moving traffic safely and satisfactorily may be swiftly and economically widened with Tarvia* or Tarvia-lithic.*

The methods are simple and inexpensive, and there are combinations of Tarvia and aggregate which are adaptable to any kind of road and any condition of shoulder areas.

THE SOLUTION

Dangerous drops between pavement and unfinished shoulder are done away with, and the widening not only extends the life of the road but also increases the amount of traffic it can safely accommodate.

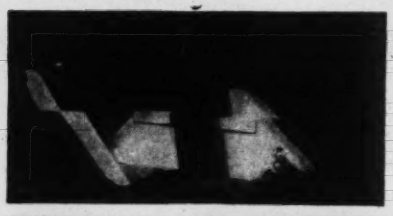
Why not check the narrow roads in your locality? The Tarvia field man can advise the proper shoulder foundations and wearing surfaces, and he will be glad to work with you.

THE BARRETT DIVISION
ALLIED CHEMICAL & DYE CORPORATION
40 RECTOR STREET, NEW YORK 6, N.Y.

New York • Chicago • Birmingham • St. Louis • Detroit • Philadelphia • Boston
Rochester • Minneapolis • Cleveland • Columbus • Toledo • Youngstown • Syracuse
Buffalo • Cincinnati • Bethlehem • Portland, Me. • Bangor, Me. • Norwood, N. Y.
Oneonta, N. Y. • Elmira, N. Y. • Cromwell, Conn. • Norwich, Conn. • Savannah, Ga.
In Canada: THE BARRETT CO., LTD. Montreal • Toronto • Winnipeg • Vancouver

Barrett Tarvia*
*Reg. U. S. Pat. Off.

CEMENT GUN COMPANY
"GUNITE" CONTRACTORS
GENERAL OFFICES—ALLENTOWN, PENNA., U.S.A.



RAILROAD BRIDGES REPAIRED WITH "GUNITE"

The photographs illustrate three typical railroad bridges which we repaired with "GUNITE" in 1944 for the B&O Railroad.

The concrete was extensively disintegrated in the abutments, wing walls and back walls. After chipping away all loose and deteriorated concrete the surfaces were sandblasted and reinforcing mesh attached. "GUNITE" was placed to a minimum thickness of two inches, but in many areas was as much as twelve inches thick.

On the upper two bridges the tracks were shored up and entire new back walls were built of "GUNITE."

These jobs are typical of work which we do for the Railroads; State Highway Departments and Municipalities, and also includes the encasement of structural steel as a protection against locomotive blasts and corrosion.

Our 72-page bulletin A2300 describes this work and scores of other uses of "GUNITE." Write for your free copy today.

MANUFACTURERS OF THE "CEMENT GUN"

COMMERCIAL

tunnel supports
• safer
• faster

The COMMERCIAL Shearing & Stamping Co.
Youngstown 1, Ohio

For any tunneling job, COMMERCIAL Products are your best bet. We can supply Supports, Liners and Plates to your exact specifications — any size, any radii, for any type ground.

C. H. Clash has been made assistant secretary, succeeding F. H. Holloway, resigned.

THE BOARD OF DIRECTORS of the Masonite Corp. has approved an expenditure of over a million dollars to expand its plant at Laurel, Miss., according to M. P. McCollough, president. The directors prepared for the financing of this addition more than a year ago, when the sale of 62,000 shares of common stock was authorized and the proceeds placed in escrow for this purpose.

A. J. BARTLETT of Le Roi, Co., Milwaukee, Wis., is now in charge of the sale of industrial engines to original equipment manufacturers. Mr. Bartlett, who studied engineering at the University of Wisconsin, has been with the company since 1935.

FRED J. SCHMIDT, formerly chief marine engineer of Pennsylvania Shipyards, Inc., Beaumont, Tex., has been named chief engineer of the American Steel Dredge Co., Fort Wayne, Ind. He is a graduate of Washington University, St. Louis, Mo., and has had wide experience in marine construction. He was for nine years with the U. S. Engineers on river dredging operations from the Memphis, Tenn., office.

DIRECTORS of the Sasgen Derrick Co., Chicago, Ill., have elected M. F. Sasgen president and treasurer to succeed his father, the late Michael J. Sasgen. For many years the younger Sasgen had been vice-president and general manager. It is said that his election as president will insure continuation of the policies and trade relations established by his father.

JAMES H. JUDGE, Chicago district manager of the Neptune Meter Co., has been promoted to assistant general sales manager. Mr. Judge has had twenty-two years of sales experience with Neptune. Previous to his appointment as Chicago district manager, he had as his sales territory Illinois and part of Missouri. He served in the U. S. Navy during the first World War. H. A. Tolburg, of Springfield, Ill., succeeds to the position of Chicago district manager. He has been with the company since 1936.

W. H. MOELLER has been appointed manager of the New York district for the American Well Works. He has long been identified with sales and engineering of hydraulic and electrical machinery. The W. K. Sowdon Co., will continue as special representatives handling the company's water and sewage treatment lines, and will operate under Mr. Moeller's direction.

This Youngstown Alloy Link
Holds a 45,000-ton Battleship on Leash

IN few services does steel take more punishment than in an anchor chain. Wind and tide tug at it, keep links rubbing against each other, keep bottom sand cutting its surfaces. It must stand strain and shock, resist corrosion and abrasion. It must hold its vessel securely in roughest water.

This die-lock link, forged from tough alloy steel bar stock, is a triumph of engineering design and manufacture over Nature. Product of the Boston Navy Yard, made of standard alloy, this link is much lighter in weight, yet far stronger, than other types of ordinary iron and steel. It uses less steel and makes a better, much longer lived chain, abrasion resistant, an excellent leash for even our big 45,000-ton battleships.

Having proved its ruggedness in anchor chains for the Navy, Youngstown Alloy Steel is ready to serve in your toughest jobs. It is furnished to standard specifications. Your inquiry is invited.

QUALITY Y UNGSTOWN SERVICE

YOUNGSTOWN
THE YOUNGSTOWN SHEET AND TUBE COMPANY
YOUNGSTOWN OHIO
Manufacturers of
CARBON ALLOY AND YOLOY STEELS
Pipe and Tubular Products Sheets Plates
Conduit Bars Coke Tin Plate Electrolytic Tin
Plate Rails Wire Nails Tie Plates and Spikes

JACKSON VIBRATORY PAVING TUBES

Now Better THAN EVER

Carriage frame from which the dual vibratory tubes are flexibly suspended, completely isolating all vibration from the finisher.

Powerful submersible vibratory motor rigidly attached to each set of dual vibratory tubes.

Dual vibratory tube members shown elevated above slab after first pass. In operation they are lowered well within slab. Depth adjustable as job conditions indicate.

IMPORTANT NEW IMPROVEMENTS

QUICK ADJUSTMENTS from 10' to 25' Widths (in the field)

Simplified carriage frame makes changes from one width to another extremely quick, simple and easy.

LOWER SUBMERSION HIGHER LIFTS

Perfect adaptability to slabs 16" to 24" thick, without affecting the efficiency on single or two-course standard plain or reinforced concrete pavement construction, has been achieved by giving the vibratory elements lower submersibility and higher lift above the finished slab.

DOUBLE FUNCTIONING

Horizontal full width submersible vibratory elements are standard as shown. As alternate or auxiliary equipment, however, we can furnish vertically mounted unit vibrators of the internal type in any spacing specified, thus making it possible for the contractor to meet all specifications with one machine.

Plus ALL THE ADVANTAGES THAT HAVE MADE THIS PAVING TUBE AN OUTSTANDING FAVORITE

1. Faster finisher progress in drier mixes.
2. Perfect puddling of concrete at forms and joints.
3. Complete compaction — excellent finish.
4. Reduction in spreading cost.
5. Instant transformation of stiff, dry mixes into plastic, easily placed concrete.
6. Dependable, proved performance. Finger-tip control.
7. Ample reserve power through entire variable frequency range of 3000 to 5000 VPM.

You're way ahead of the parade when you own a JACKSON! See your JACKSON distributor or write for complete information.

Manufactured by ELECTRIC TAMPER & EQUIPMENT CO. *for*

JACKSON VIBRATORS INC. Ludington, Mich.

Manufacturers' Publications

Industrial Designing— Covering a wide range, a new 12-page booklet on rubber and synthetic products suggests application of these products to industrial designs.—*The B. F. Goodrich Company, Akron, Ohio.*

Gyratory Crushers—A new bulletin, besides many helpful tables and diagrams, has numerous photographs illustrating shafts, main frames, top shells, spiders, heads and other parts of the crushing units which range in weight from 700 to a million pounds. Pertinent facts on manufacturing and shipping are included, such as an explanation of how crusher shafts are bored through the center and inspected by periscope to locate flaws as a guaranty of soundness, and the fact that the entire crusher is assembled on a permanent foundation and inspected before the parts are crated piece by piece for shipment.—*Allis-Chalmers, 603, Milwaukee 1, Wis.*

Conveyor Belts—Describing the role that large conveyor belts play in the transportation of vast amounts of material on construction and other projects, there has been published a folder relating the job which belts accomplished in the building of Shasta Dam. Belting carried 12 million tons of aggregate during the dam's construction, operated 24 hours daily, 30 days monthly, and no working time was ever lost through trouble with the belts so far as the records show.—*The B. F. Goodrich Co., Akron, Ohio.*

Single-acting Pile Hammers—A new 16-page bulletin describes the special purposes for which single-acting hammers are intended, and lists a number of their advantages, including underwater operation. It is of interest to contractors faced with operating conditions involving the penetration of very dense substances and the handling of heavy mass piles. Specifications, cross-section diagrams and listing of component parts are included, also detailed data on operation. A table based on an established formula for bearing power of piles offers help in selecting the correct size of hammer.—*McKiernan-Terry Corp., Park Row Building, New York 7, N. Y.*

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